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Electronics Australia

NOVEMBER
1986
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Challenger
WHAT REALLY HAPPENED

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THIS MONTH'S COVER

This month, we bring you a special report on what happened to the Challenger space shuttle (see page 36). Painting by John Berkey, © Discover Magazine 4/86, Time Inc.

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Volume 48, No. 11
November 1986

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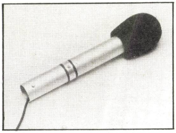
Do-it-yourself microphone

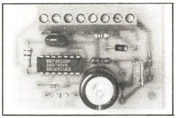


This high-quality microphone can be built for half the cost of comparable commercial units and boasts several novel features. Details page 26.

What's coming

Don't miss next month's issue. In addition to a big feature on marine electronics, you'll find articles describing a low-distortion audio oscillator, a digital audio storage device and a UHF keyswitch for use in burglar alarms.

Solar-powered bilge pump



Don't let the yacht sink. This new automatic bilge pump is low in cost and easy to build. Best of all, it's powered by the Sun.

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Letters to the editor

Fake grass and shocked gardeners

Neville Williams' comments about the hazards of static charges (Forum, June 1986) reminded me of an experience in the UK about 20 years ago.

At the time I worked at the Engineering Centre of a big conglomerate electronics company, founded and built up by a then venerable entrepreneur, who had just received a knighthood in recognition of his efforts. Let us preserve this gentleman's anonymity by giving him the invented name of Sir Les North.

For his retirement, Sir Les had purchased a very plush unit in one of the best areas of North London. TV outlets were required in most rooms, so it was natural to call in his own engineering staff to design and install the system.

A small mast carrying the antenna was bolted to a convenient steel hand rail which surrounded the unit's fla roof and a mains powered amplifier gave the signals a boost before distribution. The system was tested and to the relief of all concerned, Sir Les indicated his approval.

About a week later the cataclysm occurred. We had a phone call from a very icy Lady N to let us know our antenna system must be faulty as it had given the gardener a nasty electric shock. Good jobs were not easy to ge at that time and I must admit we al panicked a bit before unanimously electing one of our colleagues, who had

Three reasons for not purchasing kits

In response to your article on projects only being available in kit form from suppliers, I would like to voice my agreement with your contributors.

You mentioned in "Forum" that many overseas magazines are having enormous problems with falling circulations, and I can't help but wonder if this is due to the trend of publishing kit projects. I have dropped my subscription to two overseas magazines because of this.

As your magazine is Australian, I am at least able to purchase kits locally. However, I have three objections to having to do this:

Firstly, I agree with the letters published. The cost of many of the kits is such that I cannot afford to purchase the project in one hit, although I would be able to purchase the parts spread over a period.

Secondly, like many people, I have purchased standard parts in bulk packs over the years and fail to see why I should have to buy these parts a second time.

Finally, maybe it is just my bad luck, but I have had some lousy experiences with kits. This has ranged from incorrect or missing parts to defective components, and makes me wonder if some firms are using seconds to make up kits.

I would also agree with I.G. of Victoria that a proper kit should have decen instructions. I have no objection to photostats of your article, but I do object when the photostat quality is very poor and they do not include the "Notes and Errata" that has been published since the original article.

Over the years your magazine has published some excellent projects, but in recent times the value of these for me has dropped due to this kit problem. I would be more than happy to see the supply situation revert to being able to purchase individual parts, or projects not being published if components are not available individually.

G. Parrant,
Castle Hill, NSW.

Kit suppliers losing sales

I am writing in response to your request for ". . . a wad of letters that we can wave under the noses of kit suppliers."

I wholeheartedly agree with the comments in your Forum of July 1986. I am also in complete agreement with J.M. (Seven Hills, NSW) regarding the construction of the larger (both in terms of parts and money) kits.

a superb bedside manner, to go and investigate.

He found that following our antenna work on the flat roof, a very nice little garden had been installed, complete with flowers in pots, trees in tubs and a lush green plastic lawn. The gardener had been sweeping the lawn with a traditional birch broom and after some vigorous exertion had decided to take a rest by leaning on the handrail. His extended hand never quite reached the rail however, as whilst it was still a short distance off, a juicy spark jumped the gap, giving him a hefty zap, a small burn and some instant rejuvenation.

A 50kV electrostatic voltmeter was brought in and we found that a few strokes with the broom on the lawn would generate enough static to put it off the end of its scale. All was explained to Lady N, we kept our jobs and the plastic lawn went back to a company which mines and manufactures in Minnesota for antistatic treatment.

T. N. Ayscough,
Beacon Hill, NSW.

I would dearly love to build the Teletext Decoder, and both the Playmaster amplifier and tuner, but could not even begin to consider the financial outlay in one hit. This means that there is a considerable (my own definition) amount of money that a kit supplier will not be getting from me.

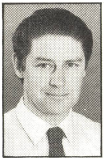
Granted that a supplier has to outlay the cost of both purchasing and storing the components if he was to sell them separately, but at least he would eventually get a return for these components, rather than nothing at all if he was to market them as a complete kit which a lot of people could not possibly afford.

This is really a two-edged sword. By not supplying the components of a kit as separate entities, not only are the suppliers losing money from prospective sales, but they also risk driving the electronics enthusiast, particularly the beginner, into another hobby.

In fact, you could almost call it a three-edged weapon if you consider that an electronics enthusiast who is driven to another hobby may even stop reading *Electronics Australia*. And if enough people do that . . .!

I shudder to think of the consequences!

D. Cunningham,
Geelong West, Vic.



Editorial Viewpoint

Should radar detectors be banned?

The recent announcement by the New South Wales Minister for Police, Mr Paciullo, that radar detectors and jammers would henceforth be banned has caused consternation amongst motorists and manufacturers alike. Should this action have been taken?

From a strictly legalistic point of view, you could argue that anyone who fits a radar detector or jammer to their vehicle is intent on breaking the law. Further, those people who go to great lengths to conceal their detectors or jammers are compounding the offence.

That point of view would be unlikely to be disputed if the rules of the road were uniformly and fairly enforced. But in the State of New South Wales the rules of the road are not fairly and uniformly enforced and on past history, are never likely to be.

The fact is that on many roads in Metropolitan areas motorists consistently exceed the speed limits, often by 20km/h or more. In peak periods, any motorist who did not keep up with the traffic would be a severe hazard. So everyone exceeds the speed limit. Ergo, the speed limits are a joke. That is point number one.

Point number two is that where radar traps are set up by the police they invariably are at places where it is safe to travel at speed; ie, on a wide freeway or on a straight downhill stretch of road where the speed of the vehicle tends to naturally increase. Radar traps are almost never set up on the suburban back-streets where some lunatics drive cars at speeds which really are a hazard to life and limb.

So the average motorist can be forgiven for being cynical about the views of officialdom on radar detectors. Radar traps have been no more than revenue-earners in the past. The police will have to use them much more fairly in the future if the radar detector ban is to mean anything.

Perhaps the police have correctly realised that past radar speed measuring systems could not reliably be used on heavily trafficked arterial roads or on narrow winding suburban streets. New radar systems are claimed to be effective in pinpointing particular vehicles in traffic so that obvious offenders can be singled out.

But unless the police use radar sensibly and fairly to weed out the dangerous motorists they should not use it at all. Until the police demonstrate that they will enforce the speed regulations fairly, motorists have some justification for feeling that the radar detector ban is just official posturing.

LEO SIMPSON

News Highlights

IBM expands operations at Wangaratta

Underlining its commitment to its Australian operations, IBM has begun manufacturing PC planar boards at its Wangaratta, Victoria, plant and has announced plans to manufacture telecommunication products.

The planar boards are used in IBM Personal Computers, PC XTs and PC ATs which are also assembled at Wangaratta. The decision to manufacture the boards for these computers represents a further $3.7 million investment by IBM in local manufacturing.

During 1985, the Wangaratta plant produced over 30,000 IBM personal computers. These are used to supply the Australian market and are also exported to New Zealand and to South East Asia.

The decision by IBM to manufacture telecommunications products in Australia is in line with a Telecom agreement requiring telecommunications suppliers to include local content in their products.

Two communications controllers, the CBX-11 and VSCBX, will be produced at the plant and the first models are expected to be rolling off the production line later this year. These controllers are the computer-based section of a ROLM business communications system.

The ROLM CBX-11 8000 system supports up to 840 voice and/or data lines and/or associated Telecom trunks. The VSCBX is designed for smaller systems with 16 to 140 users.

Dishing out Aussat!

Want fast access to Aussat from anywhere in Australia? An Australian company, Network Technologies Pty Ltd, has developed a mobile 3.7-metre dish that can be towed to the desired location and set up within a few minutes.

The company says it can transport the new dishes to any site in Australia accessible by vehicle, be it a city hotel, a country office or a private home. The 3.7 metre antenna works in conjunction with any of the video transmission standards of the various broadcasters in Australia, and is ideal for satellite videoconferencing .

Australia in strong position with optical fibres

Australian industry could be in a strong position to capitalise on the growth opportunities being offered by the $2 billion undersea fibre optic communications cable planned for the Pacific basin, according to the Australian Electronics Industry Association .

According to Mr Bill Page-Hanify, the President of AEIA, "the basic technologies for submarine optical fibre cable systems are already in place in this country and Australian companies are now hard at work developing these technologies even further."

The Pacific network project will involve laying the world's largest underwater fibre optic network and will link Australia with other countries on the Pacific rim — New Zealand, Japan and North America. Tenders for the first phase, Tasman 2, linking Australia and New Zealand, will be called later this year and already a number of leading overseas communications companies have expressed interest.

The need for local technology, manpower and skill to become involved in the project is also very much a part of OTC's strategy. Five Australian companies have already been contracted to carry out developmental work on the project. These companies are AWA, STC, Austral Standard Cables, Olex Cable and Optical Fibre Research.

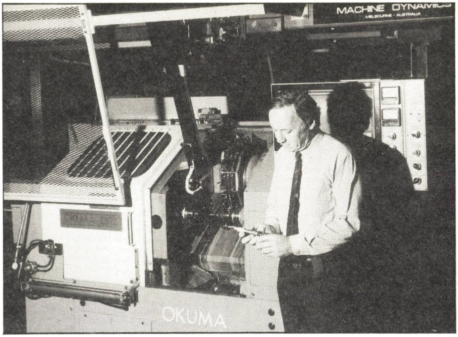
Asteroids named for Challenger astronauts

Seven asteroids have been named after the members of the Challenger Space Shuttle crew who perished on January 28. The asteroids were all discovered from Lowell Observatory by astronomers Dr Edward Bowell and Mr Norman Thomas, and are named for Francis R. Scobee, Michael J. Smith, Christa McAuliffe, Gregory B. Jarvis, Ronald E. McNair, Ellison S. Onizuka, and Judith A. Resnik.

Asteroids are small rocky bodies left over from the time of formation of the solar system some 4.6 billion years ago and which failed to coalesce into a major planet. Most orbit the Sun between Mars and Jupiter.

A small number of asteroids have orbits that cross the orbits of the planets, such as Mars or Earth, but there is very little danger of collision as their orbits are inclined to those of the planets. The largest asteroid is about 850 km across, but those being discovered these days are usually only a few miles across.

The seven Challenger asteroids were discovered between 1980 and 1984, during the course of a survey funded by NASA's Planetary Astronomy Program.



Aussie-made robots for industry

Four specialised single arm machine loading robots, designed and constructed by Machine Dynamics in Victoria, have joined the workforce of one of Australia's leading toolmaking companies, Sutton's Tools of Thomastown, Victoria.

The Machine Dynamics' robots can be set up for a new line in about three minutes and are fed by a tube conveyer system. The robots have dramatically increased productivity at Sutton's, thus ensuring that the company's products remain competitive.

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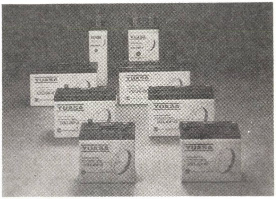

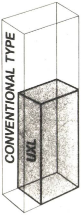

UXL Saves up to Half on Space

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GENERAL SPECIFICATIONS

Battery Model	Nominal Voltage (V)	10HR Nominal Capacity (AH)	Dimensions (mm) Length	Width	Height	Overall Height	Approx. Weight (kgs)
UXL33-12	12	30	235	128	190	217	16
UXL44-12	12	40	299	128	190	217	20
UXL55-12	12	50	363	128	190	217	24
UXL66-6	6	60	217	128	190	217	15.5
UXL88-6	6	80	281.2	128	190	217	19.5
UXL110-6	6	100	345.4	128	190	217	23.5
UXL220-2	2	200	170	106	330	362	16
UXL330-2	2	300	170	150	330	362	24
UXL550-2	2	500	241	171	330	362	39

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AUSTRALIA

News Highlights

Hetero-junction bipolar transistor

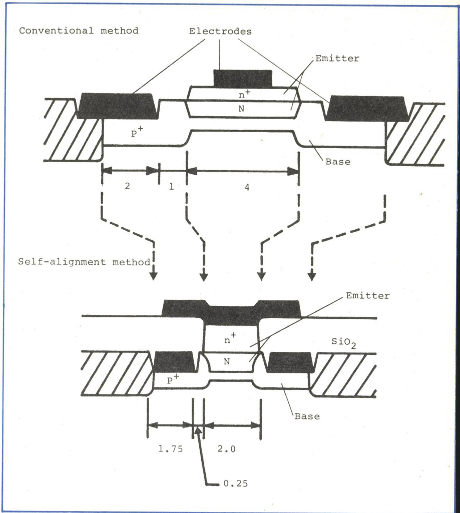
Toshiba researchers have developed a hetero-junction bipolar transistor (HBT) with a switching time of 35 picoseconds.

The transistor uses compound semiconductor materials of aluminium gallium arsenide (AlGaAs) and gallium arsenide (GaAs), according to Toshiba. It is suitable for use in central processing units (CPUs) for next generation supercomputers, and in transceivers for optical communications.

In conventional transistors, the emitter and the base are formed respectively by using different masks, which means extra space is needed to ensure enough isolation between each electrode. This, in turn, increases the overall size of the transistor.

Toshiba's new transistor overcomes this problem by shrinking the gap between the emitter and base electrodes using a process called the "self-alignment" method. In this method, the emitter is formed first and a thin layer of silicon dioxide is then introduced as an insulator to completely cover the emitter region. The base electrodes (in the case of an IC) are then formed directly next to this SiO_2 layer.

As a result of the new technology, the width of the emitter is halved from four to two microns and the gap between the emitter and base electrodes is down from one micron to 0.25 microns. This, in turn, significantly reduces the size of the transistor.



Holiday camps

Each Christmas, vacation camps for high school students interested in electronics, computing and photography are held at Mount Victoria, NSW.

Known as Camp Technology, they are an interdenominational Christian organisation project.

Participants can construct electronic projects, try their hand at computer programming, operate amateur radio station VK2BCT, shoot, develop and print photographs, and learn video production.

Two camps are planned for this summer — one for boys years 7 to 9 (in 1986) and the other for boys and girls years 10 to 12. Dates are the 6th to 13th and 14th to 21st January, 1987 and the cost is $95.

For further information contact Scripture Union, 120 Chalmers Street, Surry Hills 2010. Telephone (02) 690 1777.

Subscription winner

The winner of the Sony Digital Audio/Video system, from an EA subscription is:

G. Somerville, Punchbowl, NSW

The competition appeared in EA during May, June and July.

The colder the clock the better

Researchers at the University of British Columbia in Vancouver, Canada, have made a step towards developing the most accurate clock in the world.

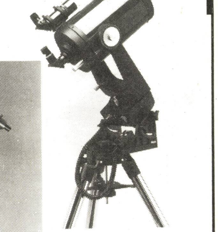
At present the hydrogen maser operating at room temperature has the most accurate atomic clock — it loses about one second every 30 million years. The new Canadian design is a liquid-hydrogen maser that works at just 0.5°K — or −272.5°C in everyday language. It is said to be 10 times more accurate than existing masers, losing just one second every 300 million years, and in theory could be made 100 times more accurate again.

The greater accuracy results from the stability achieved at the very low temperature at which the clock functions. Up until the Canadian work, Teflon has always been used to coat the inner wall of a hydrogen maser and at very low temperatures this becomes useless. The hydrogen atoms can no longer bounce off the Teflon walls, the frequency of the microwaves that this creates defining the basic unit of time.

The Canadians have overcome this problem by using walls coated with a thin layer of liquid helium.

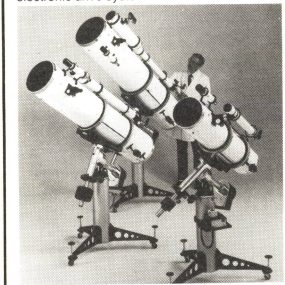
Possible applications for the new clock include helping to track deep space probes, and detecting gravity waves.

WANT A NEW CHALLENGE?
EXPLORE THE UNIVERSE THROUGH A
MEADE TELESCOPE



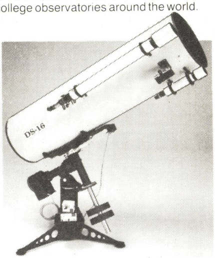
Discovers planets, moons, suns, nebulae, starclusters, comets, galaxies, supernovae, and if you like take a photograph of what you see!

MEADE SCHMIDT CASSEGRAIN SERIES ► So technically advanced they're warranted for life. Available with three different apertures - 100mm, 200mm and 254mm. These telescopes are the ultimate combination of performance and portability. Laser tested, hand matched optics with Quartz electronic drive systems make these the most sought after telescopes in the world today. Prices start at $1630 for model 2045 (100mm apertures f10, f/L1000mm) complete with new quartz electronic drive system.



◄ **MEADE NEWTONIAN REFLECTOR SERIES** Meade reflector combine optical performance second to none with rock solid motorised mountings so necessary for successful viewing and photography. This series starts with Model 618F (150mm aperture f8, f/L 1200mm) complete with motor drive for $1967. They have excellent deep space photographic capability while at the same time permitting superb planetary and lunar resolution. Sizes range up to the marine 312mm. Research series which is already used in many schools and college observatories around the world.

MEADE GIANT DEEPSPACE SERIES ► This series provides "Big Aperture" at an affordable price. The DS16 (406mm aperture f4.5) is still the biggest commercially available telescope "off the shelf" in Australia. Motor drive is included but all other accessories are left to your choice. DS16 owners all rave about unbelievable deep space viewing. DS16 $4794. Also available is the smaller DS10 $2510.



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High current amplifiers

Do we need them?

How important is the current-sourcing ability of amplifiers? Does it need to be specified separately, in addition to power ratings or is it a new marketing ploy dreamed up by the amplifier manufacturers?

by LEO SIMPSON

One of the parameters we read more of in amplifier advertisements these days is current capability. According to some audiophiles and designers, current capability is one of the most important characteristics of an amplifier. Hence, typical amplifiers today, as well as having power ratings into 8-ohm and 4-ohm loads, also have a figure quoted for instantaneous current capability.

For example, a current model (sorry about that) from the USA has a rated power of 70 watts per channel into 8 ohms and an instantaneous current capability of 50 amps. This is said to make it suitable for use with low impedance speakers.

Well, just how important is current sourcing ability? And just how much current should an amplifier be able to deliver, for a given power rating. A few moments' work with a calculator will quickly show the answers to these questions.

For example, let us consider the recent Playmaster Sixty/Sixty amplifier which had a nominal rating of sixty watts per channel. As the spec panel published in the May 1986 issue of EA showed, the amplifier was able to deliver about 74 watts into an 8-ohm load with one channel driven and about 88 watts into a 4-ohm load, again with one channel driven. This means, that on a steady-state basis, the amplifier could deliver about 3 amps into an 8-ohm load and about 4.7 amps into a 4-ohm load.

That does not sound like very much when compared to the figure of 50 amps quoted above, does it? But the figure was quoted as an instantaneous capability, so perhaps we should use the dynamic power figures as a guide. For the Playmaster Sixty/Sixty, these figures were 105 watts into 8 ohms and 153 watts into 4 ohms, both for a single channel being driven.

These figures are obtained using the IHF procedure which involves using a pulsed sinewave signal with a pulse duration of 20 milliseconds and a pulse repetition rate of 2Hz; ie, two pulses per second.

Again, you can calculate the equivalent current figures at about 3.6 amps for the 8-ohm load condition and about 6.2 amps for the 4-ohm load condition. These are RMS figures (root mean square) which are the effective or DC equivalent values for an AC sinewave signal. To get the instantaneous figure, we have to multiply the RMS value by 1.414. This gives instantaneous values of just over 5 amps for the 8-ohm condition and 8.75 amps for the 4-ohm condition.

And while we did not quote the performance of the Playmaster amplifier into 2-ohm loads, it will deliver a peak current of about 11.5 amps. This corresponds to an IHF power output of about 130 watts. Even if we take the highest possible figure of 11.5 amps, it is still paltry compared with the 50 amps figure for the American designed amplifier. So why did they need it?

The note about suitability for low impedance speakers gives the clue. These high current requirements are based on the fact that loudspeakers do not present a simple resistive load to the amplifier terminals. Instead, they are a complex impedance. On some speaker systems, the actual impedance value at a particular frequency may plummet to below two ohms.

This can happen if the loudspeaker system is transformer-coupled, as in the case of an electrostatic system, or has a badly designed crossover network. With these sorts of loudspeakers, the amplifier must be able to deliver very high currents if it is to avoid distorting the signal waveform, for a given volume setting. This will not be a problem for the amplifier at low volume settings but at high settings, where the amplifier is close to clipping, it can cause a serious reduction in power output.

So would it be possible to produce an amplifier with a nominal rating of 70 watts per channel into 8-ohm loads, able to deliver an instantaneous current of 50 amps? Quite simply, yes. But there are a number of big ifs.

Rugged output stage required

First, the output stage must have sufficiently highly rated power transistors to be able to deliver 50 amps peak. To do it safely, the transistors would probably have to be capable of delivering up to 100 amps on a pulsed basis. Surprising though it may seem, such a requirement is not too difficult these days. The designer could even obtain such an output stage capacity with single transistors (or Darlingtons) without the need to parallel transistors.

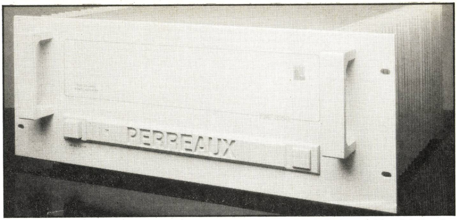
It is a lot more difficult to obtain such a high capacity with power Mosfets though, since they are transconductance devices, ie, they require so many volts into the gate to obtain so many amps of drain current. (Typically, at least three Mosfets would have to be paralleled to obtain a 50 amp capacity, giving an output stage of six transistors.)

Of course, as well as having high current capacity, the output transistors would require adequate voltage and power ratings. A typical device might have a collector rating 120 volts and a power rating of 300 watts. At the same time, it would need very good "second breakdown" characteristics if it was to be able to safely handle reactive loads. Be under no illusions, all loudspeakers are highly reactive somewhere within the audible spectrum.

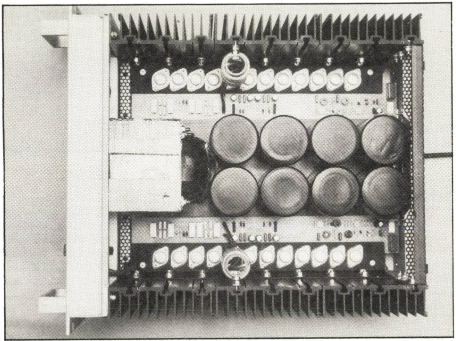
And it is the reactive load condition which rejects most high current transistors as being unsuitable for high power amplifier design. "Second breakdown" is the bugbear. This is the process by which bipolar transistors develop hot spots at the higher voltage and high current conditions. The higher voltages cause current crowding which then causes the hot spots. It is the hot spots on the chip surface which can cause failure of the device.

Because of the second breakdown effect, all bipolar transistors have to be derated to some extent at the higher voltages. And paradoxically, the tendency is for the very high current devices to be derated the most.

So even if you could obtain sufficient current capacity (ie, 50A) with a pair of complementary output transistors, the chances are that a viable output stage would require at least four output transistors if it was to be a reliable design. To be a really conservative design, capable of handling the most difficult, low value, reactive loads, you might need as many as six output devices in each channel.



A rugged amplifier if ever there was one, this Perreaux PM3150 is capable of delivering 10 amps on a short term continuous basis.



This massive Perreaux 5150B amplifier was rated at 800 watts per channel and had a total power supply capacitance of 80,000uF.

As well as making sure that the output transistors have sufficient current sourcing ability, the designer must make sure that the driver stages can also deliver enough current to the output transistors, without any danger of damage to the devices if the loads are short circuit.

Power supply

Having taken care of the amplifier output stage, the next requirement is for sufficient current capacity from the power supply. Since the current only has to be delivered for a very short time, less than 50 milliseconds, say, it is possible to build in this order of current capacity merely by specifying very large filter capacitors in the power supply. So, while the Playmaster Sixty-Sixty used a value of 5000μF for the total filter capacitance for both the positive and negative supply rails, the value probably may have to be increased to around 15,000μF or more, depending on the quality of the capacitors.

At the same time, all the conductors within the amplifier would have to be of sufficient cross-section to ensure that resistive losses did not become excessive

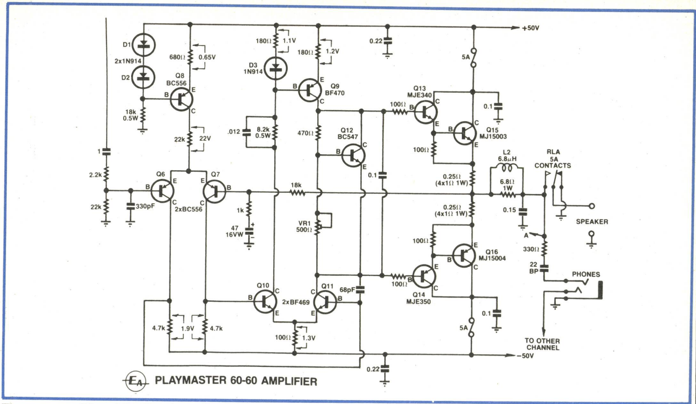
How to calculate maximum amplifier output current

To calculate the maximum instantaneous output current of an amplifier, you need to know how much power it can deliver from one channel into the specified minimum load. For example, if it will deliver 100 watts on a short term basis into a 4Ω load, we calculate the RMS voltage across the load as:

$$V_L = P \times R_L = \sqrt{100 \times 4} = 20 \text{ volts}$$

We then calculate the peak voltage by multiplying V_L by 1.414 to obtain 28.28 volts. We then calculate the peak current:

$$I_p = \frac{V_p}{R} = \frac{28.28}{4} = 7.07 \text{ amps}$$



The power amplifier of the Playmaster Sixty-Sixty. This has very rugged power transistors in the output stage but these would need to be paralleled up to increase the output current capability.

High current amplifiers

at these high output currents. At 50 amps, a resistance of only 0.1 ohms between the commoned-emitters of the power transistors and the loudspeaker would mean a loss of 5V. That would not be easily achieved.

It goes without saying that a 70 watt/channel amplifier with a 50 amp instantaneous current capability would cost a lot more than an equivalently rated amplifier such as the Playmaster Sixty-Sixty. And having paid for such an amplifier, what are the circumstances in which it would be required to deliver its all?

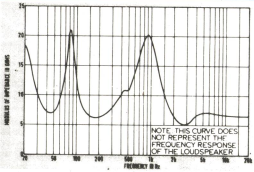
The conditions under which 50 amps peak would be required are simply these: (a) the amplifier is driven to deliver its full output voltage swing. For an output capability of 70 watts into an 8-ohm load, this amounts to 23.7 volts RMS or 33.5 volts peak; and (b) the loudspeaker impedance for the signal being delivered by the amplifier must be 0.67Ω or less.

The first condition could occur quite often, particularly if the volume setting is high. The second condition would be very rare, if it is ever likely to happen at all.

Having come this far though, let us look at a more-likely worst case condition. Consider for example, if we have two sets of loudspeakers connected, both of which have a nominal impedance of 4Ω. For a typical loudspeaker system, you can expect that the minimum impedance will be at least two-thirds of the nominal impedance, or 2.68Ω. With two such loudspeakers in parallel, the load impedance is therefore 1.34Ω which is getting pretty low. For the same maximum output condition as listed above, the amplifier will now have to deliver 25 amps.

Frankly, the likelihood of having two sets of loudspeakers which have a minimum impedance of 1.34Ω (to obtain a parallel combination of 0.67Ω) is stretching credibility. And the likelihood of having any loudspeaker with a nominal impedance of 8Ω with such a minimum impedance is zero. Such a loudspeaker would cause so many problems with ordinary amplifiers that it would quickly be withdrawn from sale. No self-respecting loudspeaker designer would produce such a system.

So what conclusion are we left with?



This is the B&W DM110 which has an impedence characteristic typical of many well-designed loudspeakers. Notice that it does not dip below 5 ohms at any point in the audible frequency range.

We have to consider that it is possible to have a situation where a user may have two sets of loudspeakers which, when connected in parallel, will have a minimum impedance of 1.34Ω. And therefore, if the amplifier is not to clip prematurely when driven to full output, it needs to be able to deliver 25 amps peak.

More realistically, a typical user may have two pairs of 8-ohm loudspeakers (or one pair of 4-ohm loudspeakers) which can be expected to have a minimum impedance, when connected in parallel, of no less than 2.5Ω. The amplifier now has to deliver 13.4 amps peak.

Or if we use the example cited at the start of this article, where the minimum loudspeaker impedance is 2Ω, the maximum peak output current, for a peak output voltage of 33.5V, is 16.75 amps. Note that this current capability is only required when the amplifier is being driven flat out. The consequence of using a less well endowed amplifier (as far as current capability is concerned) is that difficult loudspeakers would not be able to be driven quite as hard before severe distortion became apparent.

So you could argue that a 70 watt per channel amplifier with an output current of say, 20 amps, is desirable, for the best quality sound, and you would be right, as far as technical considerations are concerned. But to argue that a 70 watt per channel amplifier needs a 50 amp instantaneous current capability is ridiculous.

So where does that leave the Playmaster Sixty-Sixty which we have used as the basis for comparison in this article? Plainly, it is not intended to drive very low impedance loads although it will safely drive a 2-ohm load for short periods. If driven hard into such a low value load, it will blow the fuses. In other words, it is designed to survive being connected to low impedance loads and short circuits, not to drive them.

With typical 8-ohm loudspeakers though, whose impedance values fall into the expected range, it would be extremely hard to better the performance of the Playmaster Sixty-Sixty, at any price.

It would be possible to beef up the output stages of the Playmaster amplifier, but that would require the addition of more output transistors, larger heatsinks and bigger filter capacitors in the power supply. It would add up to a considerably more costly amplifier with no audible improvement to the performance, except on "difficult" loudspeakers. EA

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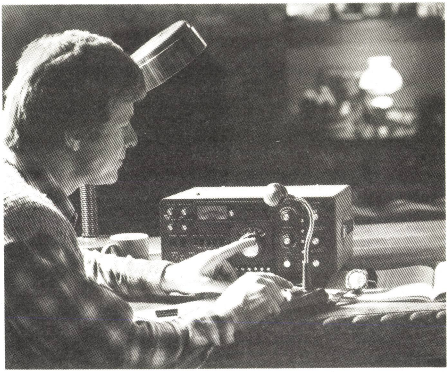

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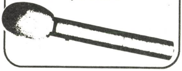

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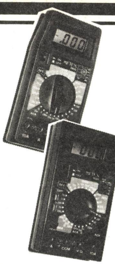

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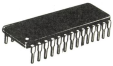

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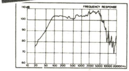

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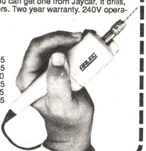

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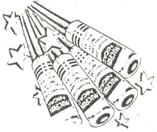

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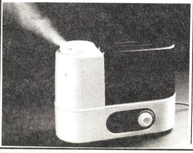

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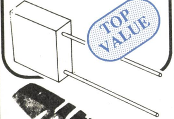

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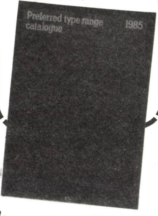

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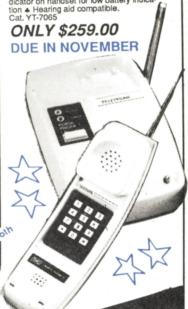

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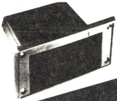

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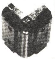

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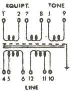

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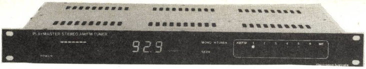

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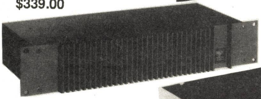

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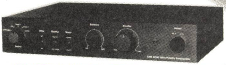

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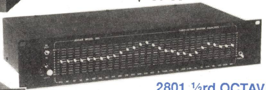

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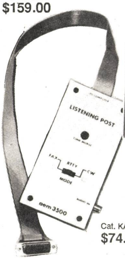

ELECTRIC FENCE CONTROLLER

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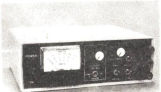

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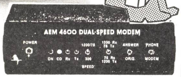

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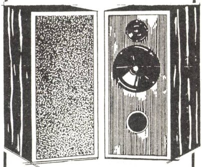

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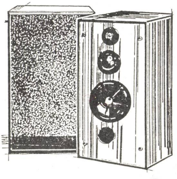

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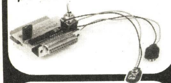

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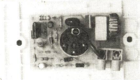

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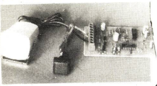

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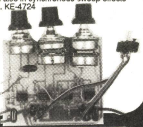

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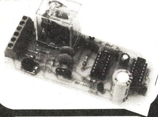

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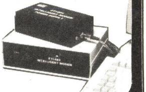

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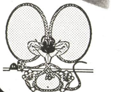

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FORUM

Conducted by Neville Williams

Video recorders: new battle looms

If you thought that all was now sweetness and light in the world of video cassette recorders, there may be good reason to think again. JVC and Sony, the principals in the long-running VHS/Beta battle, seem poised for another confrontation, this time involving the new 8mm video format.

The original battle of the formats, involving VHS, Beta and V2000, is now history and scarcely warrants recounting at length.

It is sufficient to recall that Philips demonstrated the potential of domestic VCRs in the early '70s, beginning with their N1500 (1972) and culminating in the technically impressive V2000 (1979).

To the rapidly expanding Japanese electronics industry, domestic VCRs presented a golden opportunity and, bypassing the European initiative, they set about developing their own designs, primarily for the Japanese and American (NTSC) markets but with the PAL and SECAM areas in longer view.

As it turned out, two dominant Japanese formats emerged: Beta, sponsored by Sony, and VHS sponsored by JVC (Japanese Victor Company) — basically similar but mechanically incompatible. Together, they invaded world markets although, at the same time, exploiting every trick in the book to assert their own individual superiority.

It became an emotive, as well as a technical and marketing issue but, leaving aside the "leap-frogging" that marked successive refinements, there was really very little to choose between the two formats in terms of the end result.

VHS finally prevailed, mainly because of majority support by big-name manufacturers, headed up by JVC's powerful parent company Matsushita (National, Panasonic, Technics).

Locally, the emotive aspect of the contest was highlighted by a segment in Leo Simpson's editorial in the July '84 issue entitled: "VHS has won the marketing battle against Beta."

It raised a chorus of protest from Beta distributors and owners, who variously saw the editorial as blind prejudice, part of a deliberate conspiracy or a potentially self-fulfilling prophecy.

In fact, it was an objective observation based on analysis of video cassette sales and rentals, on covert moves towards VHS being made by major Beta manufacturers, and a not-so-covert runout of Beta models — evidence discounted by correspondents in subsequent issues.

But the editorial was spot-on. Within less than twelve months, Sony was the sole remaining manufacturer of Beta format VCRs while, elsewhere, the Philips group had also transferred their support from V2000 to VHS.

According to JVC, as at June 30 last, VHS had chalked up around 100 million sales worldwide — roughly four times the figure for all other domestic formats combined.

A new "standard"?

At about the time when the format furore was at its peak, it became known that video manufacturers had reached agreement on a new video format using 8mm wide tape (compared with the existing 12.7mm standard) accommodated in a cassette broadly similar in size to an audio compact cassette.

The parameters were debated and determined with a particular eye to the needs of video photographers. Apart from being a technically appropriate figure, 8mm offered the marketing advantage of an automatic association with 8mm home movie film.

The new format incorporated desirable technology from the established systems and, having been endorsed by no less than 127 major companies worldwide, provided some assurance that those who chose to enter the compact video field would not end up with another set of conflicting standards.

Commonsense, it seemed, had prevailed, although Kodak did cause some concern by announcing that they planned to launch the new format forthwith — without awaiting the convenience of the electronics industry.

But perhaps it didn't matter; Kodak was primarily a photographic supplier faced with an inevitable changeover from photographic film to magnetic tape. Why complain if they took upon themselves the task of pioneering the new format?

By and large, the video industry settled back to take advantage of the continuing prosperity of VHS, now becoming available with hifi FM-stereo sound, enhanced picture quality and compatible VHS-C for video photographers who wanted something smaller than was possible with a full 3- to 4-hour cassette.

The original VHS suppliers were content and so, apparently, were companies like Toshiba, Sanyo, NEC and Philips, who had joined them.

Sony's counter move . . .

But that left Sony out on a limb, the sole major supplier of Beta format equipment and certainly not about to abandon it in favour of VHS. Their most obvious course was to move straight into the new 8mm format, with the idea of establishing a trend which other manufacturers would ultimately have to follow.

This they have done, releasing a range of NTSC and PAL camcorders, domestic decks and a PCM processor — backed by what has been termed "extremely aggressive promotion". While Sony has undertaken to support Beta for as long as is necessary, the clear implication is that they are looking to the future (8mm) not dwelling on the past (12.7mm).

And JVC's reaction:

JVC's response has been to accuse Sony of grossly over-selling 8mm around the world as the format for the future. While JVC admits to being one of the 127 signatories, the basic purpose of the agreement, they say, was to "enable compatibility among 8mm products that may appear in the future." I quote:

"Agreement on the standard itself in no way constitutes a move by the industry or the participating companies to

standardise the world market with the 8mm video format."

By its nature, they say, the 8mm format is "isolated to the portable camera recorder market". It "offers no significant advantage over VHS".

"8mm is definitely not the next generation format", according to JVC, because it makes no adequate provision for recording video technologies of the future — a limitation that could even see it as "inhibiting the progress of the industry as a whole".

Pros and cons

As against some of the speculative reporting on the intriguingly compact 8mm format, comparisons drawn by JVC are sobering. The comparative figures are for the PAL format, applicable in Australia:

Max. Playing Time: VHS offers up to 3 hours on thick tape, 4 hours on thin tape, and 6 or 8 hours at half speed. For 8mm the figures are 1 to 1.5 and 2 to 3 hours respectively, with 8mm heavily dependent on half-speed thin tape for timer recording and movies.

Tape Dimensions: 12.7mm wide: 19 or 15.6μ thick. 8mm wide: 13 or 10μ thick. The durability of 8mm thin tape for repetitive use (rental movies) is questionable.

Track Pitch: VHS, normal speed, 49μ, half speed 24μ. For 8mm, 34.4μ and 17μ respectively.

Picture Quality: For general domestic use, the comparison would be between VHS at normal speed, and 8mm at half speed. For a given quality of tape and electronics, VHS will always have the advantage.

Stationary Head Sound: A normal mono or stereo provision with VHS. Optional with 8mm but of dubious value, especially at half speed.

FM Sound: VHS uses depth multiplex stereo, avoiding prejudice to picture quality. 8mm uses frequency multiplex (FM), limited to mono to minimise inevitable interaction with the video signal.

PCM Audio: Although impressive enough at demonstrations, the 8-bit 31.5kHz system specified for 8mm video is actually the lowest specified PCM system in the quality audio field and unlikely to be accepted in lieu of newly developed digital audio tape equipment.

Video cameras

As for video camera equipment, JVC appear to be well satisfied with their own VHS-C option — "a little brother" to the full-scale VHS cassette, which can be used in any VHS deck with the help of an adaptor. While somewhat thicker than an 8mm video cassette, it has much the same profile dimensions and, in a camcorder, involves a video drum and associated mechanism of similar size.

One possible objection is a recording time limit of 30 minutes at standard speed, although JVC suggest that, in practical video photographic situations, 30-minute cassettes often prove to be more manageable.

It might well be argued that all this is what one would expect JVC to say but it does make sense and it does fit the current pattern in the industry.

Some major companies, including Matsushita, are manufacturing 8mm equipment to order for photographic companies, but there is no haste, and presumably no present inclination, to promote the format in the home video market under their own name.

Looking ahead

There is substance also in JVC's claim that a VCR format for the future should make provision for the next generation of video equipment — in short, for HDTV (high definition television).

The most recent issue of "Monitor" (from the Institution of Radio & Electronics Engineers, Australia) reports on discussion of HDTV leading up to and at the 16th Plenary Assembly of the CCIR at Dubrovnik (Yugoslavia) during May last.

Clearly, technology is moving towards a standard of video presentation comparable to that offered by modern 35mm photographic film. The technology is available and the problem is not a matter of "if" but of when and by what strategy.

The NTSC block is keen to move quickly; the PAL block is more cautious and anxious to ensure that the course adopted will culminate not only in HDTV, as such, but in common, worldwide video standards.

How long it will take HDTV to reach consumer level is not clear but the possibility exists that it could happen in about the same time frame as would be needed to change over to 8mm. On this reckoning, the supposed "format of the future" would reach maturity in the nick of time to become obsolete!

From what I can gather, the purveyors of VHS VCRs are presently confident that 8mm won't make it to the top; that there won't be another format war — not over 8mm anyway.

But, if there isn't, Sony will have to be content for a while with a couple of minority formats — Beta & Son (?) —

What do you really do for a living?

A few weeks ago I had to write a short piece for a careers booklet on what electronic engineers did. It covered the usual activities of designing, evaluating, inventing and advising, but afterwards I realised that it was written more in hope than in truth.

There have not, to my knowledge, been any recent studies here on how electronic engineers practice their profession and how this relates to their education. (Perhaps such a study may be worth conducting by our Institution.)

But from the reasonable range of people I know in the profession only a few work according to the traditional model of engineers.

While technological change has had visible effects on the lives of clerical and production workers, the less visible changes in engineering have had as large an effect behind the scenes.

Designers who once worked at the discrete component level either do not design at all now or work at a higher level in which functions are provided by integrated circuits.

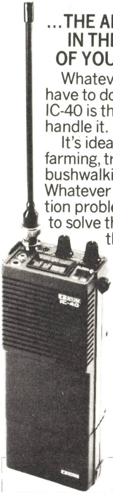
Engineers whose responsibility once was to ensure that the components of a system would work together electrically have now become software engineers.

Computers, it sometimes seems, are the new breadboards, the medium that provides the greatest opportunity for creativity and challenge. Our older readers will see many parallels between the role which computers play now — as a source of challenge — and radio systems of 20 or 30 years ago.

I am not sure therefore that we have as clear an idea today of what our profession really means as when our Royal Charter was written. Accordingly, there is a responsibility for the IREE to help define this role and provide a focus for it.

Please give this some thought. You may be asked for your ideas.

Graham Rigby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FORUM – continued

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Which brings us up to the question as to what will take over from the now universal VHS format, plus embellishments? What will be the true "next generation" VCR? One with thin-film heads and vertical particle recording?

Or will it be a VDR — a video disc recorder, with VMBs — video memory banks — further down the track?

Sorry, but my crystal ball has misted over!

What do engineers do?

Hard on the heels of his controversial "VHS has won the battle" editorial, Leo Simpson did some further stirring in the August '84 issue with a leader entitled "So you think you're an engineer, mate!"

Perhaps he was in a stirring mood at the time but he certainly was exasperated after a series of job interviews with engineer applicants who proved to have a remarkably scant practical knowledge of everyday electronic devices.

Leo just couldn't understand how people who had studied and worked at electronics for years could have generated so little interest in, and remained so aloof from the intriguing technology around them.

In the ensuing debate, some agreed with his sentiments but others tended to the view that a hands-on interest in electronic devices was for technicians and hobbyists. Engineers had to concentrate on broad principles, so that they could make intelligent decisions and issue perceptive directions in any engineering task in which they might become involved.

It sounds most impressive but what does it really mean, and to what extent does it exempt engineers from the need for a broad awareness of the practicalities of their profession?

I was reminded of all this when I came across the "President's Column" in the same June/July issue of the IREE "Monitor", as mentioned earlier. In it, Professor Graham Rigby asks his fellow engineer-members the question: "What do you really do for a living?" If you haven't read it already, I suggest you read it now.

I noted, in particular, his remarks about the migration of engineers from component and system design to the manipulation of IC functions and computer software. How very true.

When I first became involved in the IREE, the executive and the monthly meetings alike were dominated by engineers responsible for the design and production of a wide range of components and equipment, along with others connected with communications, radio (later TV) broadcasting, audio and recording, film production and so on.

They were a deeply committed hands-on group, who managed not only to communicate to their peers what they were about, but to enthuse them as well. Rarely did anyone need to ask what they did for a living.

But times have changed and so has the Australian technological environment.

On a relative basis, our involvemen in component design and manufacture is but a shadow of what it once was. We may shrug it off as an economic necessity of transitory importance but it has removed a complete strata — maybe two generations — of intensely "practical" engineers, plus the people and the facilities under their direction.

Much the same is true of those involved in designing and manufacturing radio and TV receivers and transmitters, along with sundry other items including (remember?) test equipment.

By today's standards, the forma qualifications of yesterday's "practical" engineers might appear modest but, in a continuing situation, qualifications would assuredly have expanded to match the technology. Increasingly, tha kind of expertise has moved "off-shore" — certainly from Australia but also, in varying degrees, from other "western" countries.

What we have left is a distorted technological structure: a top and a bottom but no middle:

- Academically orientated engineers largely isolated from the challenge, the subtleties and the skills of producing bits, pieces and things; and
- Technicians, servicemen and trainees, looking up a ladder from which the middle rungs have been removed.

I would hope that the President's column will motivate IREE members to think his question through and to respond with information which can be sorted and tabulated.

Analysis of such information migh well show that, if modern-day electronics engineers are indeed academically over-biased in attitude and occupation the present, distorted structure of the industry may be at least partly to blame.

JACK O'DONNEL
DIRECTOR

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COMPONENTS

It's Now Official Altronics Prices Save You Up To 30% Off Our Nearest Competitor

The reproductive purity of these speakers simply amazed us. The secret, of course is the DANISH VIFA.Drivers. VIFA drivers are used in many top selling imported systems such as Bang & Olufsen, Rogers, Mission, Jamo, DCM Timewindow etc.

Build These Fantastic New Playmaster HiFi Loudspeakers

See Electronics Australia Sept '86

$449
full kit K 5090

If your budget won't run to the $600 to $800 needed for a fully imported pair of equivalent speakers, these are the ones to go for.

Some extracts from Electronics Australia Magazine — Each woofer has a foam roll surround and a doped paper cone with an effective (piston) diameter of about 155mm. **The Tweeters** "the Tweeters are exotic little beasties" (Editor EA Magazine) each is a 19mm soft dome unit with a ferro-fluid damped voice coil for high power handling and a very smooth frequency response. Its resonant frequency is around 1.7kHz.

Power Handling (60 watts plus RMS!) In an average sized lounge room and driven by the Playmaster Sixty-Sixty or an equivalently rated amplifier, these speakers will deliver enough sound volume to satisfy the most power crazed enthusiast.

Construction Only the most basic of tools are required to assemble these loudspeakers Even if you are a rank amateur at carpentry you will have no problems putting them together. You don't need special clamps or jiggs and all timberwork has been precisely machined. You do have to be able to use a soldering iron though, to connect the loudspeakers to the crossover network.

$189 Next Month

Desk Mounted Lamp Magnifier

$169

If you have trouble with fine PCB work or component identification but still want both hands free, this is for you. We thoroughly recommend this quality Australian made product.

TECHNICAL INFORMATION Illumination: 22W Fluorescent **Weight:** 8.16kg **Lateral Extension:** 254mm **Vertical Extension:** 254mm **Fixing:** Heavy table base (grey & Ivory) with two chrome plated flexible arms. Cat A 0980

Up to Incredible 1KM Range

Professional Megaphone PA

20 Watts Max.Power with In-Built Whistle

A new product for 1986, our A 1990 Megaphone PA is quite simply one of the finest around irrespective of price. This is an extremely sturdy unit with a quality in-built 20 watt (max) low distortion amplifier. **Another Secret** of the fine performance is the incorporation of a noise cancelling micrphone - the result is a surprising level of gain available **without feedback** even when used indoors in relatively confined spaces.

Why Pay $150 or more?

A 1990
$109.50

100 Amp Jumper Leads

Superb Quality

A 3011 **$17.50**

'Sixty-Sixty' Integrated Amplifier Kit

(EA May,June,July '86)

Features:

• 60 watts per channel into 8 ohm loads • Very low noise on all inputs - better than CD performance • Very low distortion • Excellent headroom • Tape monitor loop • Tone controls with centre detent and defeat switch • Mono/stereo switch • Toroidal power transformer • Easy-to-build construction • Very little wiring.

Performance Specification

Power Output — 8 ohms 62W **Distortion** - Less than .0% at 1kHz. **Frequency Response** - Phono Inputs - RIAA/IEC equalisation within + - 0.5db from 40Hz to 20kHz
Line Level Inputs — -0.5db at 20Hz and -1db at 20kHz **Input Sensitivity** - Phono 1kHz -4.3mV • Line Level - 270mV. **Hum & Noise** - Phono - 89db • High Level Inputs - 103db. **Tone Control** - **Bass** - + -12db at 50Hz **Treble** - +-12db at 10kHz. **Damping factor** - At 1kHz and 30Hz - greater than 80 **Stability** — Unconditional.

K 5060 **$299**

"This New Amplifier offers a standard of performance far ahead of anything we have previously published and ahead of most commercial integrated Stereo Amplifiers".

"It is half to one third of the cost of an imported Amplifier with equivalent power output and performance". Says Leo Simpson Managing Editor Electronics Australia Magazine.

Beginner constructors can Build this Amplifier Kit — It looks terrific and will last you a lifetime.

Save $200 or more on comparable performance commercial units

Why Risk Unnecessary Heart Attack?

Heart disease strikes down many people in their early 40's (or even 30's). The tragedy remains that had such victims been alerted, remedial medical, physical and dietary action could have been prescribed to avoid illness and in many cases restore full bodily health. **X 3055**

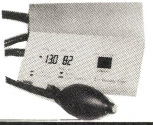
Blood Pressure and Heart Rate Monitor

Features:

- Non-Microphone Measurement System
- LCD Readout
- Blood Pressure Monitor
- Pulse Rate Monitor

Why Pay $150?

X 3055 **Only $110**



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Sensational Labtech

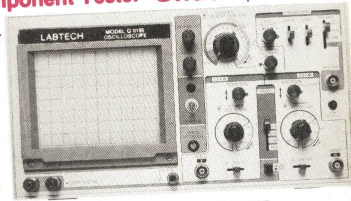
Full 12 Months Warranty

Dual Trace 20MHz CRO With Component Tester Under $800

Definitely Australia's Best Value in Quality Oscilloscope Test Equipment — Just Look at the Facilities

The Inbuilt Component Tester Alone Is Over $300 Value.

Why Pay $1000?



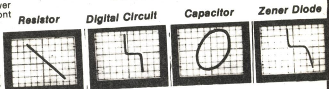
DESCRIPTION:

This model is a dual-trace 20MHz Oscilloscope using high brightness CRT The vertical amplifiers have high sensitivity of 5mV/Div and the frequency characteristic response with the smooth roll off exceeding 20MHz. The highest triggering sweep speed is 0.2 usec/Div. For component test, special circuit is designed, with which a single component or components in or out of actual circuit designed, with which a single component or components in or out of actual circuit board can be easily tested, requiring no power to drive the circuit. The display shows fault of components, size of a component value, characteristics of component, and half-dead components under dynamic test.

FEATURES:

• Component Tester • Wide bandwidth & high sensitivity • Very low power consumption • High sensitivity X-Y mode • Z axis (intensity modulation) • Front panel electrical trace Rotator • Regulated power supply circuit for Accuracy

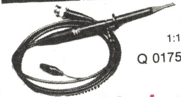
TYPICAL COMPONENT TEST STATUS PATTERNS



ALTRONICS FAMOUS SATISFACTION GUARANTEE

We are delighted with our new Labtech Q 0155 Oscilloscope and Component Tester and naturally we are confident you will be too — However, if for any reason you are less than 100% satisfied with your new Labtech CRO you may of course return it to us (in original condition with all instructions, packaging etc.) within 14 days for a full refund less transport costs.

Q 0155 Value **$799**



Probe Sets

1:1 or 10:1 Attenuation

Q 0175 **$47.50**

Highly Recommended For:

Service Workbench, Design Laboratory, Manufacturers, Universities and the dedicated Enthusiast.

Labtech *Test Equipment for Life*

Just Arrived - The Superb Micron Soldering Station

No more changing tips to obtain correct working temperature — simply select between 320 and 440 deg.C with the flick of a switch.

T 2440 **$99.50**

Excellent for Production Work

At last! A true temperature controlled temperature selectable soldering station with all the parameters one would expect from a professional soldering iron **without** the high price slug some of our competitors ask.

Temperature Selectable to 5 settings 320, 350, 380, 410 and 440 degrees C.

Temperature Readout via led baragraph instantly visable.

Temperature Stability to within 4% of selected mean temperature at normal ambient temperatures i.e. 20-25 deg. C.

Heat Capacity Full 48 watts of heat energy available for heavy duty work.

Earthed Tip/Element Tip is earthed as a protective measure for work on microprocessor circuitry etc.

Excellent for Delicate PCB Work

Low Voltage Element 24V element for added safety especially with CMOS and microprocessor soldering in situ.

Silicon rubber Iron lead used providing a comfortable, flexible connection to station and durability against accidental burn damage.

Quality Iron Clad Tips

Chrome Plated Iron Plated Tips Regardless of the excellence of the station and iron element, it is absolutely imperative the iron tips be of a high standard, easily cleaned and long life. The Micron tips are "State of the Art" chrome plated, iron clad ultra long life, very resistive to over heating, clean easily and what's more are **very reasonably priced!**

* * * * * * * * * * *

Replacement Tips All $3.95

Micro Chisel	1mm Tip	T 2423
Mini Chisel	1.5mm Tip	T 2424
Standard Chisel	3mm Tip	T 2425

Free Bonus set of 3 tips **($12 value) this month**

Save Up To 30% With These Prices

A RARE OPPORTUNITY

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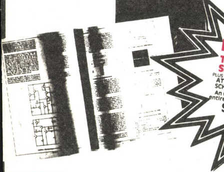

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INTERFACE

This data book provides complete specifications for a variety of transmission line drivers/receivers, peripheral/power drivers and level translators/buffers. Product selection guides list applications information and operating features. Memory, dynamic memory, microprocessor, data communications and disk support products are also covered in the data book. The interface appendics section contains cross reference guides, the programmable logic section describes the technology, design and gives application suggestions.

Pages: 1520 **Year 1983**

B 1005 . . . **$13.50**

DATA CONVERSION ACQUISITION DATA BOOK

The 1984 edition of the Data Conversion/Acquisition Data book is one the the most comprehensive in the industry. It contains specifications for high technology conversion products in the analog signal path, both preceeding and following the conversion process. Combining high volume production capability with leading edge technology such as thin film resistors, laser trimming and advanced micro CMOS and bipolar processing, has helped develop products best suited to your design needs.

Pages: 1232 **Year 1984**

B 1007 . . . **$13.50**

HYBRID PRODUCTS DATA BOOK

The Hybrid Products Data book is the only National Semiconductor publication that contains complete information on all our hybrid semicondutor products. Included are precision thin film and thick film products which provide the user with standard functions from operational amplifiers to converters with capabilities beyond those of current monolithic technology. Product selection guides and an application section are also included.

Pages: 792 **Year: 1982**

B 1045 . . . . . **$9.95**

LINEAR DATA BOOK

The 1982 edition of the National Semiconductor Linear Data book is the most comprehensive available. It presents approximately 2000 pages of specifications for our high-technology linear products. Applications, descriptions, features and diagrammes in this data book include detailed sections for Voltage Regulators. Op Amps. Voltage Comparators. A to D, D to A Converters. Industrial Blocks and Audio and TV Circuits. The data book also features advanced telecommunications devices and speech synthesis (DIGITALKER). Plus other non state-of-the-art linear products offering performance, economy, quality and reliability.

Pages: 1952 **Year:1982**

B 1010 . . . **$21.50**

LINEAR APPLICATIONS HANDBOOK

Provides an indexed & cross reference collection of linear integrated circuit applications using both monolithic & hybrid circuits. Individual application notes written to explain the operation & use of one particular device or to detail various methods of accomplishing a given function. Each section includes, applications, descriptions, features, diagrams & specifications.

B 1012 . . . **$15.00**

LINEAR SUPPLEMENT

The 1984 Linear supplement provides the most recent information on Nationals new linear products. This supplement also provides a comprehensive index published in the Master Data book New products designed are indicated by an Asterisk and in bold type.Revised data sheets are listed in bold type.Nationals supplement data book system allows you to make product selections of their latest product offerings.

Pages: 566 **Year: 1984**

B 1011 . . . . . **$7.50**

MOS MEMORY DATA BOOK

The 1984 MOS Memory Data book is a comprehensive collection of information advanced, high-density memory products covering the spectrum of this mainstream semiconductor component category.

National Semiconductor has an array of advanced technology processes to apply to memory design and development. These range from high-density triplepoly process used in the most advanced RAMs, the small-geometry, silicon gate, oxide-isolated micro-CMOS technology which is now being applied to high performance memory devices for the first time.

Page: 256 **Year: 1984**

B 1025 . . . . . **$7.50**

TRANSISTOR DATA BOOK

National Semiconductor has added many new transistors and product families since publication of the last data book. Many have already been widely acclaimed by users. In addition to small-signal, power-pipolar and field effect transistors that have been the mainstay of our catalogue, there is a section for multiple-field-effect transistors. More part numbers will be added as market needs expand. To keep current on all new National transistors, please contact your National sales representative or franchised distributor and ask to be placed on the customer mailing list.

Pages: 558 **Year: 1982**

B 1050 . . . . . **$9.95**

The first 30 customers also receive NATIONAL'S BRILLIANT VOLTAGE REGULATOR HANDBOOK absolutely free - that's a further $10 value

Free Bonus offer for the first 30 Customers Phone order reserve yours now!

VOLTAGE REGULATOR HANDBOOK

The 336 page Voltage Regulator Handbook becomes a must for the selection of three terminal and dual tracking components that meet the system requirements while utilizing the most cost effective approach. Beginning with product selection procedure and a data sheet summary, the text continues with easily accessible information about booster circuitry, power transformer and filter specifications, test methods, manufacturers' cross reference and extended use applications for National's regulators. **B 1055**

Million Diode Sellout! From 1.5¢ each

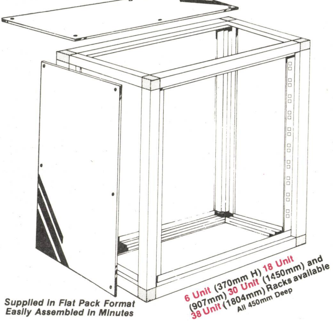
Altronics have just purchased around 1 Million (yes million) factory fresh, premium quality IN914/IN4148 diodes. These became surplus to Fairchild Australia as the factory supplied bulk, loose pack diodes instead of the tape/reel diodes ordered. So unless you are a manufacturer with automatic component insertion equipment, these fine quality diodes represent the diode bargain of all time!! **Cat. Z 0101**

1-99	**3¢ ea**
100-499	**2.5¢ ea**
500 plus	**1.5¢ ea**

RACKS

Rack Frames for the Home Stereo System
Rack Cabinets for Equipment Manufacturers

New For '86



Supplied In Flat Pack Format Easily Assembled In Minutes

6 Unit (370mm H) 18 Unit (907mm) 30 Unit (1450mm) and 38 Unit (1804mm) Racks available All 450mm Deep

The all new Altronics racking system is available in 2 formats.

1. **Racking Frame Only** Fantastic for neatly housing your home HiFi system. Looks fine as is with your various sound system modules bolted in place, however, should the little woman disagree, then it is dead simple to obtain some low cost timber panels from your local cabinet shop to fill the side and top recesses. Edging of the timber is not required due to the 15mm recesses.

2. **Complete Equipmment Cabinet** with the simple addition of the panel sets you now have a series of professional equipment cabinets of appearance and ruggedness second to none - and just look at the savings!

Assembly Each Frame System is supplied complete with 12 Custom extruded Natural Anodised Aluminium sections., 8 ABS corner connector pieces, 6 clip in MM6 captive nuts and 6 M6 mounting screws. The sections and corner pieces simply push-fit together. A rubber or wooden mallet is recommended to fit together the self aligning pieces. Further strength can be obtained by pop rivetting the various overlapping extruded sections if desired, although we hardly feel this is necessary.

Side and Top Panels Tough powder coat medium grey gives a pleasing contrast with the natural anodised frame. The resultant product is extremely professional in appearance and well and truly strong enough for the heaviest of electronic equipment.

H 0365 Rack 6 unit (370mm)	**89.50**
H 0367 Panel Set for H 0365	**49.00**
H 0370 Rack 18 unit (907mm)	119.50
H 0372 Panel Set for H 0370	**89.00**
H 0375 Rack 30 unit (1450mm)	**149.50**
H 0377 Panel Set for H 0375	**129.00**
H 0380 Rack 38 unit (180mm)	**189.50**
H 0382 Panel set for H 0380	**149.00**
H 0385 Rack screw M6 PK 12 Nat.	**2.95**
H 0386 Rack " M6 PK 100 Nat.	**19.95**
H 0390 Rack " M6 PK 12 black	**2.95**
H 0391 Rack " M6 PK 100 black	**19.95**
H 0395 captive nuts M6 PK 12	**3.95**
H 0396 captive nuts M6 PK100	**25.00**

Rack Panel Screws

Low, Low prices on Nickel Plated and Black finish Rack Screws Dome Head, M6 Thread, 25mm overall length.

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FOR DESPATCH P&P CHARGES AND ADDRESS DETAILS PLEASE REFER TO OUR AD. ON PAGE 24 •

Ultrasonic Pest Repeller

Build EA's new "Pest-Off" and save a small fortune on insect sprays.

The "Pest-Off" generates frequencies between 23KHz and 64KHz. Claimed to be the best for driving off most vermin.

Altronics Kit Includes • Strong "ABS" Case • Efficient Piezo Tweeter • Screened Front Panel. **K 1600**

$39.95

Make Your Next Party Swing with the Fantastic Musicolour IV

Ideal for Parties, Shop Signs, Display Windows, special lighting effects etc. Combination Colour Organ and Light Chaser. Four channel colour organ. Internal microphone or connect to speakers for colour organ operation. Four chaser modes forward and reverse. Output lamp load capacity a massive 2400 watts—that's 100 party globes. Full instructions and every last nut and bolt included. **K 5800**

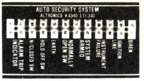
$115.00

Car Security System
The Ultimate in Vehicle Protection

Uses Microphone Sensing to Guard Against Tampering and Vandalism.

The lates '**State of the Art**' Vehicle Security System. This ETI design provides protection that could save you a fortune. Strategically placed resonance microphones detect any tampering with your vehicle e.g. Lifting of a door handle, scratching of a coin etc.

- Auto Arming with Exit and Entry delays
- Dash Mount status indicator
- Remove Protection of bolt-on accesories
- Inc. circuitry to monitor any failure of dash warning lights.
- Normally closed and normally open circuits available.
- Supplied in high quality "ABS" Case with drilled and screened front panel.
- **Protect your expensive stereo** — Simply run a wire from the alarm system normally closed terminal to any earth screw on your stereo.



K 4340 .... **$59.50**

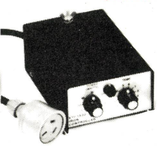
Temperature Controlled Soldering Station

(EA Sept.'86)

Controls the temperature of your standard soldering iron. Suitable for Irons rated from 20W—75W — Standard soldering iron plugs straight in no need for modification.

The Altronics Kit comes complete - pre-punched and silk screened. **Cat.K 6400**

$35.00



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TOLL FREE PHONE ORDER - Bankcard Holders can phone order toll free up to 6pm Eastern Standard Time. Remember with our **Overnight Jetservice** we deliver next day.

Altronics Resellers

Chances are there is an Altronics Reseller right near you — check this list or phone us for details of the nearest dealer. **Blue Ribbon Dealers** are highlighted with a ■. These dealers, generally carry a comprehensive range of Altronic products and kits or will order any required item for you. **Don't forget our Express Mail and Phone Order Service—for the cost of a local call, Bankcard, Visa or Mastercard holders can phone order for same day despatch.** **Please Note:** Resellers have to pay the cost of freight and insurance and therefore the prices charged by individual dealers may vary slightly from this Catalogue — in many cases, however, Dealer prices will still represent a significant cost saving from prices charged by Altronics Competitors.

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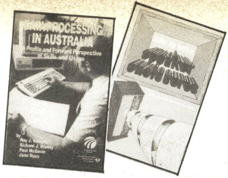


Complete Guide to Car Audio

The Complete Guide to Car Audio: by Martin Clifford. Published by Howard W. Sams & Co, Indianapolis, 1981. Soft covers, 135 × 216mm, 232mm, illustrated with photographs and diagrams. ISBN 0-672-21820-8. Price $19.95

In addition to the practical considerations of installing car audio equipment, this book offers a brief background to the subject and some useful tips of safeguarding the gear once it is installed.

Solid state electronics has benefitted car audio more than just about any type of consumer equipment. Imagine the days when car radios were so large and cumbersome that they actually had to be mounted on the running board. Sensitivity was so poor that a wire mesh antenna as large as the roof had to be used — not to mention the inconvenience of three different sets of batteries. Reading through "The Story of Car Audio" chapter certainly stimulates an awareness of the progress that has been made.

Most of the audio gear offered as standard equipment in cars is mediocre at best. Some expensive models have available equipment with the desirable features - but at a surcharge which far exceeds the value of the equipment. For motorists who want better sound than can be had with the standard equipment, but are unfamiliar with the relevant terminolgy and specifications, there is an apparently bewildering assortment of equipment on the market.

This book could be most helpful in explaining some of the more common terms. The prospective buyer would be in a much better position to independently evaluate the equipment on offer instead of depending entirely on the salesman's suggestions.

From the purely technical point of view, the book does not have a great deal to offer. The explanations of terms like "multipath distortion" and "image rejection" are most elementary. But considering the non-technical nature of the book's readership, this is quite appropriate.

The book is also a little dated in some respects - particularly with regard AM transmissions. No mention is made of stereo, and this medium is only credited with having a bandwidth of 5kHz. This latter figure may have been true at the time, and may still be true in USA, but Australian AM transmissions have a claimed bandwidth of over 10kHz presently. The receivers are a different story, though. The 5kHz figure would be more than generous for most.

Our review copy was supplied by Jaycar Electronics, PO Box 185, Concord, NSW 2137. (C.R.D.).

How to Build Speaker Enclosures

How To Build Speaker Enclosures: by A. Badmaieff and D. Davis. Published by Howard W. Sams & Co, Indianapolis, 1985. Soft covers, 136 x 216mm, 144 pages. Illustrated with photographs and diagrams. ISBN 0-672-20520-3. Price $14.95.

Here's a loudspeaker system that you'll surely want to build: each enclosure has internal dimensions of 1.2 x 1.2 x 5.5m, a volume of over 72,000 litres and weighs around 25 tonnes. Perhaps a little too ambitious? Not to worry - there are some more modest systems described in the book.

The emphasis here is on designing your own enclosure to suit whatever drivers you may have on hand. Loudspeaker types are grouped under five headings: (1) Finite Baffle; (2) Infinite Baffle; (3) Bass Reflex; (4) Horn Projectors; (5) Combinations. The respective merits and disadvantages of each type are discussed.

Consider, for example, that a loudspeaker with an efficiency of 0.1% (which is representative of some infinite baffle types), would require a power input of 40,000 watts to recreate the full dynamic range of an orchestral performance. Obviously, various practical considerations would deter any rational person from even wanting to recreate this range in the living room, but the argument leads to some interesting comparisons of efficiency for various types of enclosures.

The book is a balance of theory and practice. The relevant formulae are provided so that the constructor can decide on the type and number of drivers, the enclosure volume and type, the crossover requirements, etc. Techniques for construction are also discussed. Overall, the book is an interesting read and seems to be reasonably complete.

Our review copy was supplied by Jaycar Electronics, PO Box 185, Concord, NSW 2137. (C.R.D.).

Data Processing Skills and Usage

Data Processing in Australia by Roy J. Kriegler et. al. Published 1986 by Allen & Unwin Australia Pty Ltd. Soft cover 136 x 212mm, 70 pages, with appendices, tabled statistics and references. ISBN 0 86861 655 9. Retail price $14.95.

This text is for anyone interested in a statistical and historical analysis of the impact of computers on Australian business and employment. It has been written with the researcher in mind and attempts to trace the how, why and where of computer growth in this country, and the special needs it creates in training and employing personnel.

Chapters 2 to 5 set out to determine the extent of computer penetration into the workplace and also estimates the number of personnel employed in this type of work. The section goes on to provide information on the demand for employees and the training needs of computer-related personnel.

Over 2,500 organisations, public and private, were sampled by questionaire and a number of very interesting facts relating to employment and computerisation have been brought to light by the study.

The belief that there is a correlation between the influx of computers in the workforce and rising unemployment is firmly disputed.

The final chapters (6 & 7) investigate the demand and supply of computer related personnel now and in the future. In particular, chapter 7 considers how to avoid over supply in one area to the detriment of another.

It is a concise and well documented report on data processing in Australia, that takes a look at future trends. Our review copy came from the publishers, Allen Unwin Australia Pty Ltd, PO Box 764, North Sydney, NSW 2060. (L.U.)

Build it yourself and save money

The microphone: for stage & PA

Pick it up and it automatically switches on. Put it down and it switches off. This high-quality microphone can be built for half the cost of comparable commercial units and boasts several novel features.

by BRANCO JUSTIC

Build a microphone you say? You've got to be kidding. You don't make microphones, you buy them ready made. Perhaps this is some kind of joke?

Well, we're not kidding. The microphone to be described here offers a performance that can only be equalled by expensive commercial units. It is very easy to build, you can buy all the parts for less than $20, and it boasts a list of impressive features:

■ Automatic switch on/switch off: pick "The Microphone" up, and it switches on automatically. Put it down, and it switches off automatically after a couple of minutes (can be extended to 20 minutes if required).

■ Inbuilt battery check: if you touch one of the metal screws on the base of the unit, a LED will light up to indicate that the battery voltage is OK.

■ Omnidirectional or unidirectional pickup: you can build the unit to suit your requirement simply by ordering the appropriate electret insert.

■ Output level selection: during construction, you can set the output level from a few millivolts all the way up to line level. Thus, the microphone can drive the sensitive inputs of stage and audio mixers, the auxiliary inputs of hifi amplifiers, and instrument amplifiers (ie, it can drive any amplifier).

■ Inbuilt equalisation: the internal circuitry is equalised to compensate for the usual lack of bass which is apparent with most electret inserts. This equalisation, or bass boost circuit, can easily be disabled if not required.

■ Low power consumption: the microphone consumes approximately one milliampere when it's on and an unmeasurably low current when it's off. The internal (alkaline) battery should last the length of its shelf life.

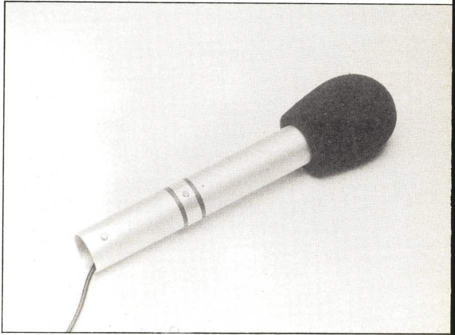
Electret microphone inserts

Electret microphone inserts have bee available from electronic parts retailer for some years now. Most fall into th omnidirectional category which mean that they pick-up sound equally from al directions.

They also offer good frequency response and sensitivity and are suitable fo 'general purpose' and recording situations. However, they are not generall used in public address and live entertainment situations because they are prone t acoustic feedback.

Recently, at least one type of unidirectional microphone insert has becom available from component dealers. Thes are more suitable for stage and PA wor because they pick-up sound predominantly from one direction; ie. directly i front of the microphone insert.

It should be noted that these units als



The Microphone — pick it up and it automatically switches on.

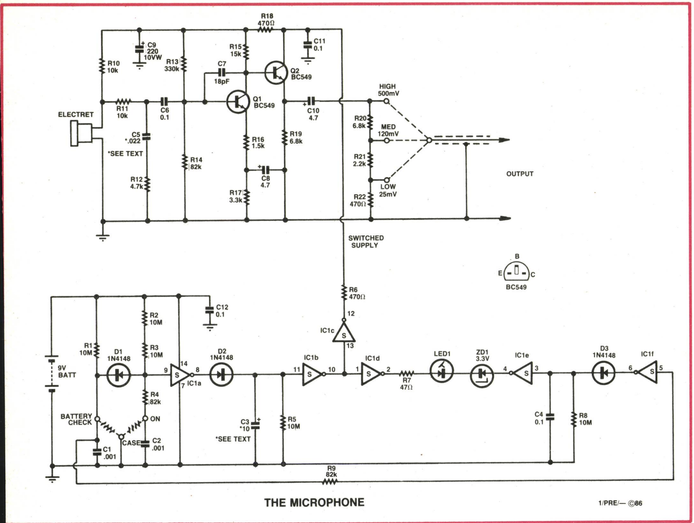


Fig.1: Q1 and Q2 form the microphone preamplifier while IC1 makes up the touch-controlled logic circuit.

fall into the close working category. They exhibit good sensitivity only when the sound source is very close to the microphone (around 20cm or less).

This brief description will help you to decide which type of electret insert is the most suitable for your application. Either type may be specified when you order the parts for this project.

How it works

Fig.1 shows the circuit diagram. It can be broken into two sections: a two-stage microphone preamplifier based on Q1 and Q2, and a touch-controlled logic circuit based on hex Schmitt inverter IC1. We'll begin with the microphone preamplifier.

The action starts at the electret insert at the extreme left of the circuit. R10 provides biasing for the FET buffer stage inside the electret, the output of which is coupled to an equalisation circuit consisting of R11, C5 and R12. This provides approximately 8dB of bass boost.

If, however, a flat frequency response is desired, the bass boost feature can be disabled by replacing C5 with a 0.1uF monolithic capacitor.

The output of the equaliser is coupled to common emitter amplifier stage Q1 via capacitor C6. This stage has a fixed gain of approximately 20dB and its output is directly coupled to the base of Q2 which, with its associated components, serves as an emitter-follower.

The addition of this latter stage gives the microphone a low output impedance. This is to ensure that high frequency components are not attenuated when the preamplifier output is connected to very long coaxial cables (50 metres or more). C8 rolls off the low frequency response of the common emitter stage (Q1) below 20Hz.

Finally, the signal at the emitter of Q2 is coupled via C10 to an attenuator network (R20, R21 and R22). This attenuator enables the constructor to select one of three different output levels: 25mV for low impedance microphone inputs on public address amplifiers and mixers; 120mV for high impedance inputs on PA amplifiers and instrument amplifiers; or 500mV for line inputs of hifi amplifiers etc.

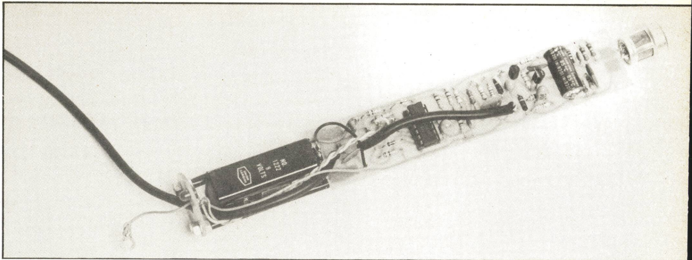
Touch control circuitry

The touch control circuitry switches the supply to the microphone preamplifier, and provides the battery check function. Here's how it works:

With no hand contact, pin 9 of IC1a is pulled high via R2 and R3. This means that pin 8 will be low and, since pin 11 of IC1b is pulled low by R5, pin 12 of IC1c will also be low. Thus, no power will be supplied to the microphone preamplifier.

When the microphone is picked up, the user's hand bridges two electrodes. One of these electrodes is formed by the metal case of the microphone, while the other consists of a 1cm-wide collar which is wrapped around the case but insulated from it with plastic tape.

The hand resistance between the 'on' terminal (metallic strip) and the case pulls pin 9 of IC1a low via R4 and thus pin 8 switches high. Capacitor C3 now quickly charges via D2 and so pin 10 of



This view shows the completed PCB prior to installation in the metal tube.

IC1b switches low and pin 12 of IC1c switches high. This then supplies power to the preamplifier stage via current limiting resistor R6.

Thus, the output of IC1c provides the switched supply to the preamplifier circuitry. This is quite in order, as it can quite easily supply the necessary current of less than 1mA.

Switch off

When the microphone is subsequently put down, IC1a's input is pulled high again and its output goes low, reverse biasing D2. C3 now discharges via R5 and, after about 100 seconds (as set by the RC time constant), pin 10 switches high and pin 12 of IC1c goes low.

Result: the microphone stays on for approximately 100 seconds after the removal of hand contact. This time constant can easily be extended to around 20 minutes by using a higher value for C3. This will allow the microphone to be used in a stand for quite long periods of time between hand contacts.

Note that C3 should be either a low leakage aluminium or tantalum electrolytic.

Battery check

Let's now take a look at the battery check function. This works in similar fashion to the supply switching circuitry.

As before, the case forms one electrode while the second electrode consists of either of two nuts which are located on a small PCB just inside the base of the unit.

Normally, the battery check electrode is held high by R1 and there is no forward bias across D1. However, when body resistance is present between the two electrodes, D1's cathode is pulled low. This low activates two circuits.

First, D1 is now forward biased and pulls pin 9 of IC1a low. This switches the microphone on for 100 seconds (if it isn't already on) as outlined above. During this time, pin 12 of IC1c is high and so pin 2 of IC1d is also high.

Second, the output of IC1f (pin 6) switches high and quickly charges C4 via D3. Pin 4 of IC1e thus switches low and the full battery voltage is applied across R7, LED 1 and zener diode ZD1. The LED will light to indicate that the battery is OK as long as the supply voltage is greater than VZ + VLED = 5V.

When the resistive contact between the battery check terminals is removed, the LED remains on for the time constant determined by C4 and R8. With the values shown, this is about one second The remainder of the circuit then switches off after about 100 seconds as outlined previously.

Construction

Virtually all the parts are mounted on a printed circuit board coded 86mp10 and measuring 170 x 29mm. To simplify construction, the PCB design includes the rear cover plate for the microphone and this accommodates the indicator LED and the battery check terminals.

The battery check terminals simply consist of two nuts which secure the cover PCB to two 70mm-long threaded rods These rods, in turn, are soldered to large copper pads at one end of the main board.

Begin construction by enlarging several holes in the PCB to the diameters indicated in Fig.2. This done, cut along the required line to separate the main PCB and rear cover. The rear cover PCB can

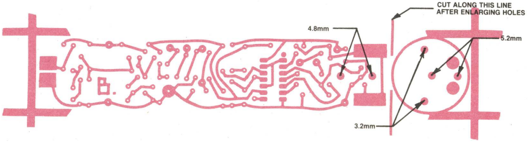


Fig.2: enlarge the holes in the PCB as shown, then separate the main section from the rear cover.

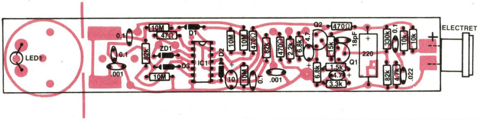


Fig.3: follow this parts layout diagram when installing the parts on the two PCBs.

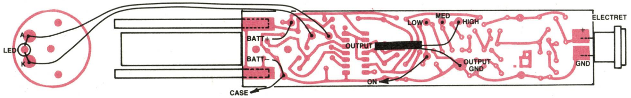


Fig.5: wiring detail for The Microphone. Use shielded microphone cable for the output lead.

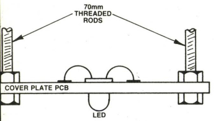


Fig.4: diagram showing how the two threaded rods are fastened to the cover plate PCB.

then be cut and filed to a circular shape about 28mm in diameter.

Fig.3 shows the parts layout on the two PCBs. No special procedure need be followed when installing the parts but watch the orientation of the semiconductors and the electrolytic and tantalum capacitors. Also, push the transistors down onto the board as far as they will comfortably go before soldering the leads. An IC socket was used for the prototype but this can be considered optional.

The electret insert is supported on two stout pieces of tinned copper wire. These, in turn, are soldered directly to the copper side of the PCB. Bend the leads at right angles so that the insert is centrally located as shown in Fig.6.

The next step is to mount the LED and the threaded rod assemblies on the cover PCB as shown in Figs.3 and 4. This done, slide two 53mm x 3mm-dia. plastic sleeves over the threaded rods. The rods can then soldered to the pads provided on the main PCB (note: tin the PCB pads first).

The remainder of the wiring can now be completed as shown in Fig.5 but don't connect the battery at this stage. The large holes in the main PCB act as a clamp for the shielded output cable (see Fig.6). We connected the inner conductor to the high level output terminal but you can also choose either the low or medium level outputs to suit your particular requirements.

Note that the lead to the metal collar for the switch-on function is soldered to a PC stake on the copper side of the PCB, and should be about 250mm long. Terminate the free end of this lead with a solder lug.

The other external lead is the earth lead. This should be about 115mm long and is routed through the hole in the centre of the cover plate PCB, along with the microphone cable. It should also be terminated with a solder lug.

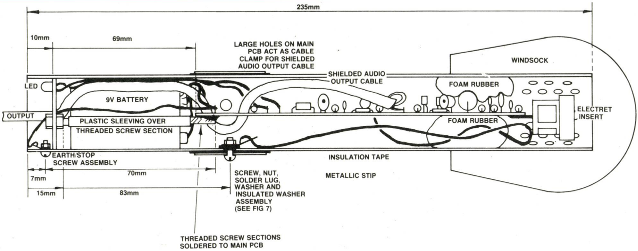

235mm
10mm
69mm
LARGE HOLES ON MAIN PCB ACT AS CABLE CLAMP FOR SHIELDED AUDIO OUTPUT CABLE
WINDSOCK
SHIELDED AUDIO OUTPUT CABLE
FOAM RUBBER
LED
9V BATTERY
OUTPUT
PLASTIC SLEEVING OVER THREADED SCREW SECTION
FOAM RUBBER
ELECTRET INSERT
EARTH/STOP SCREW ASSEMBLY
INSULATION TAPE
7mm
70mm
METALLIC STIP
15mm
83mm
SCREW, NUT, SOLDER LUG, WASHER AND INSULATED WASHER ASSEMBLY (SEE FIG 7)
THREADED SCREW SECTIONS SOLDERED TO MAIN PCB

Fig.6: how it all goes together. Note routing of output cable and foam rubber packing.

Microphone for stage & PA

Final assembly

A 235mm x 32mm-dia. aluminium tube is used to house the circuitry. This aluminium tube will be supplied precut with the kit, but the constructor will have to drill the necessary holes.

To simplify the drilling of the microphone case, a template has been prepared (Fig.8). This should be affixed to the tube using double-sided sticky tape. The holes can then be centre-punched and drilled to the diameters indicated.

A suitable piece of dowel can be used to stop the tube from collapsing during centre punching.

It is a good idea to leave the template in position during this operation, as this will help protect the case from accidental damage. Deburr all holes after drilling, then wrap a couple of layers of insulation tape around the tube where the metallic strip is to be mounted (ie, so that it covers the single hole located about 80mm from one end). This done, pierce the tape where it covers the hole in the tube.

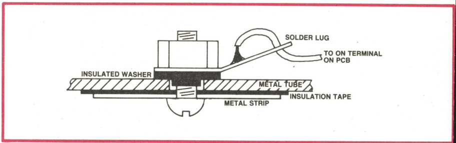
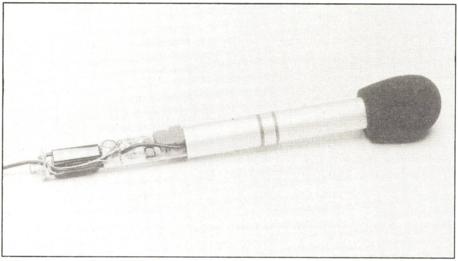


Fig.7: this diagram shows how the metal collar is connected to the 'on' terminal on the PCB.

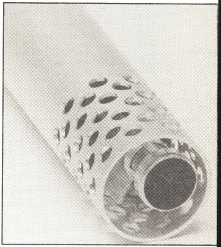
The next step is to drill holes in both ends of the metallic strip. To do this, drill a 3.2mm hole about 6mm from one end, then wrap the strip tightly around the tube insulation so that the end with the hole is in the overlapping position. The location of the second hole can then be marked and drilled to size.

You can now install the metal collar and terminate the lead to the PCB as shown in Figs.6 and 7. This operation is a little tricky but can be accomplished with the aid of a pair of longnose pliers. Use your multimeter to confirm that the metal collar has been correctly insulated from the case.

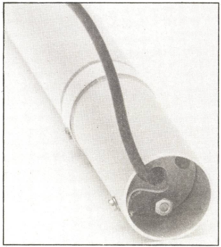
At this stage, you should go back over your work and carefully check the assembly against the wiring diagram. If everything checks out, the battery can be wired into circuit and wedged between the two threaded rod assemblies.



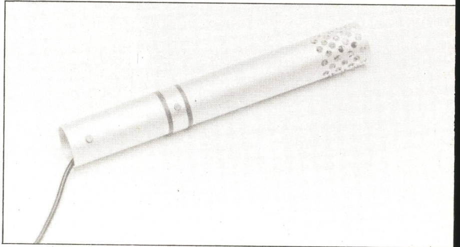
This photo shows how the PCB assembly is slid into the metal tube.



The "business" end of The Microphone. The electret insert is clearly visible.



Above: view showing the cover plate PCB.



The completed unit prior to installation of the windsock. Note that the metal collar must be correctly insulated from the case (see Fig.7).

The PCB assembly can now be slid into the aluminium tube (see Fig.6) and the earth/stop screw assembly installed. Be careful not to short out any of the PCB tracks during this procedure. We used a couple of small pieces of foam rubber as an anti-rattle measure.

Finally, install the windsock and check that the LED on the cover plate PCB lights when you touch one of the adjacent nuts. After that, it's simply a matter of plugging it in and trying it out.

PARTS LIST

1 PCB, code 86mp10, 170 x 29mm
1 electret microphone insert (see text)
1 235mm x 32mm-dia. aluminium tube
1 piece of metallic strip, 120 x 12mm
1 windsock
2 70mm x 3mm threaded rods
4 3mm nuts
2 53mm lengths of plastic sleeving
2 solder lugs
1 insulating washer
2 machine screws, nuts and washers to suit
1 length of shielded microphone cable plus plug to suit

Semiconductors

2 BC549 NPN transistors
3 1N4148 silicon diodes
1 3.3V 400mW zener diode
1 red LED (5mm)
1 74C14 or 40106 hex inverting Schmitt trigger

Capacitors

1 220uF 16VW axial electrolytic
2 4.7uF 16VW tantalums
1 10uF 16VW tantalum
4 0.1uF monolithics
1 0.022uF greencap
2 0.001uF disc ceramics
1 18pF disc ceramic

Resistors (0.25W, 5%)

5 x 10M, 1 x 330k, 3 x 82k, 1 x 15k, 2 x 10k, 2 x 6.8k, 1 x 4.7k, 1 x 3.3k, 1 x 2.2k, 1 x 1.5k, 3 x 470 ohm, 1 x 47 ohm

Where to buy the parts: a kit of parts for this project is available from Oatley Electronics, 5 Landsdowne Pde (PO Box 89), Oatley, NSW 2223. Telephone (02) 579 4985. Price: $19.95 with omnidirectional electret insert; $21.95 with unidirectional electret insert. These prices include pack and post. Note: microphone cable not supplied.

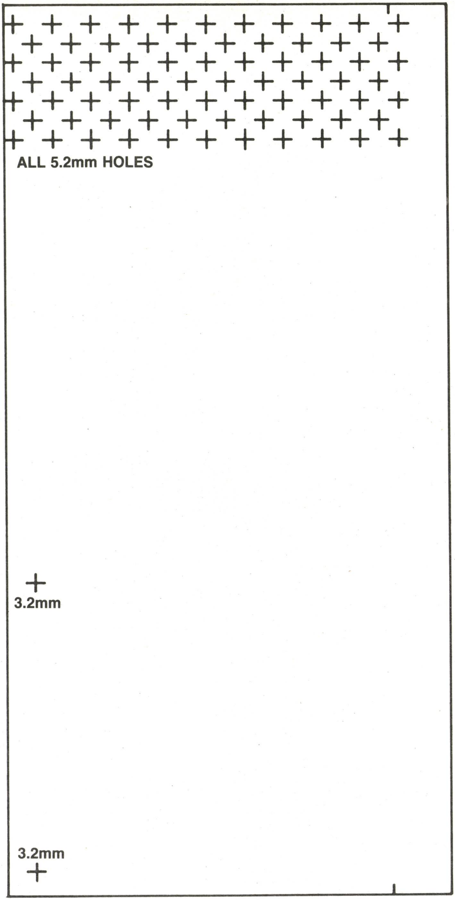
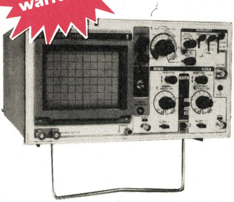


Fig. 8: Use this actual size template to drill the holes in the metal case.

12 months warranty!



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CRT

CRT: 6" (150mm) Flat-faced high brightness CRT with Internal Graticule.
Effective display area: 8 x 10 div (1 div = 10 mm)
Acceleration potential: 2KV

VERTICAL

Operating Modes: CH-A, CH-B, DUAL, ADD (CH-B can be inverted.)
Dual modes: Alter; 0.2ufs - 0.5ms/div. Chop; 1ms - 0.5s/div.
CHOP frequency 200KHz approximately.
Deflection factor: 5mV/div 20V/div +/−3%, 12 ranges in 1-2-5 step with fine control.
Bandwidth: DC; DC - 20MHz (−3dB). AC; 10Hz - 20MHz −3dB).
Rise Time: Less than 17ns.
Overshoot: Less than 3%.
Input Impedance: 1M ohm +/−5%, 20pF +/−3pF
Maximum Input Voltage: 600Vp-p or 300V (DC+AC Peak).
Channel Isolation: Better than 60 dB at 1KHz.

HORIZONTAL

Sweep Modes: NORMAL, and AUTO
Time Base: 0.2ufs - 0.5s/div +/−3%. 20 ranges in 1-2-5 step with fine control.
Sweep Magnifier: 5 times (5X MAG).
Linearity: 3%.

TRIGGERING

Sensitivity: INTERNAL: 1 div or better for 20Hz - 20MHz (Triggerable to more than 30MHz). EXTERNAL: 1Vp-p or better for DC - 20MHz (Triggerable to more than 30MHz).
Source: INT, CH-A, CH-B, LINE and EXT.
Slope: Positive and Negative, continuosly variable with level control PULL AUTO for free-run.
Coupling: AC, HF-REJ and TV. TV SYNC Vertical and Horizontal Sync Separator Circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing TV-H (Line) and TV-V (Frame) are switched automatically by SWEEP TIME/DIV switch.
TV-V:0.5s/div to 0.1ms/div. TV-H:50ufs/div to 0.2ufs/div.

X-Y OPERATIONS

X-Y Operations: CH-A: Y axis. CH-B: X axis Highest Sensitivity: 5mV/div.

COMPONENT TESTER

Component Tester: Max AC 9V at the terminal with no load. Max current 2mA when the terminal is shorted. (Internal resistance is 4.7K ohm)

OTHER SPECIFICATIONS

Intensity Modulation: TTL LEVEL (3Vp-p); Positive ...... brighter.
BANDWIDTH; DC - 1MHz MAXIMUM INPUT VOLTAGE: 50V (DC+AC Peak)
Calibration Voltage: 0.5Vp-p +/−5%, 1KHz +/−5% Square wave.
Trace Rotation: Electrically adjustable on the front panel.
Power Requirements: AC; 100, 120, 220, 240V 20W
Weight: 7kg approximately.
Size: 162(H) x 294(W) x 352(D)mm.

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Resistor

Zenon Diode

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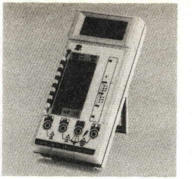
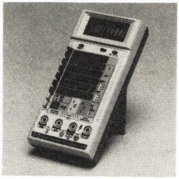


605 3½ DIGIT MULTIMETER

As reviewed in March EA!
See specification tables below for details.

Cat. Q11035 .... **$79.95**



705A 3½ DIGIT MULTI/CAPACITANCE METER

See specification table below for details.

Cat. Q11040 .... **$119**

605 & 705A SPECIFICATIONS

DC Voltage

Range	Resolution	Accuracy 605	Accuracy 705A	Input impedance	Overload Protection
200mV	100μV	0.5% + 1	0.5% + 1	10MΩ on all ranges	1000V DC/peak AC on all ranges
2V	1mV				
20V	10mV				
200V	100mV				
1000V	1V	0.8% + 1	0.8% + 1		

AC Voltage

Range	Resolution	Accuracy (50-500 Hz) 605	Accuracy (50-500 Hz) 705A	Input Impedance	Overload Protection
200mV	100μV	1% + 4	1% + 4	10MΩ on all ranges Capacitance < 1000pF	750V rms on all ranges except 200mV AC ranges (15 seconds max. above 250V rms AC)
2V	1mV				
20V	10mV				
200V	100mV				
750V	1V	2% + 4	2% + 4		

DC Current

Range	Resolution	Accuracy 605	Accuracy 705A	Burden Voltage	Overload Protection
200μA	100nA	NC	1% + 1	0.3V max	705A: 0.2A fuse up to 250V 605 : 2A fuse up to 250V 10A range not fused
2mA	1μA	1% + 1			
20mA	10μA				
200mA	100μA				
2000mA	1mA	1.5% + 1	NC		
10A	10mA	1% + 1	1% + 1	0.7V max	

Resistance

Range	Resolution	Accuracy (Hi) 605	Accuracy (Hi) 705A	Open Voltage	Overload Protection
200Ω	100mΩ	1% + 2	1% + 2	HiV < 3.5V LoV < 0.25V	250V DC/rms on all ranges
2KΩ	1Ω	0.8% + 2	0.8% + 2		
20KΩ	10Ω				
200KΩ	100Ω				
2000KΩ	1KΩ				
20MΩ	10KΩ	2% + 4	2% + 4		

AC Current

Range	Resolution	Accuracy (50-500 Hz) 605	Accuracy (50-500 Hz) 705A	Burden Voltage	Overload Protection
200μA	100nA	NC	1.2% + 4	0.3V max	705A: 0.2A fuse up to 250V. 605 : 2A fuse up to 250V 10A range not fused
2mA	1μA	1.2% + 4			
20mA	10μA				
200mA	100μA				
2000mA	1mA	2% + 4	NC		
10A	10mA	1.5% + 4	1.5% + 4	0.7V max	

Capacitance

Range	Resolution	Accuracy 605	Accuracy 705A	Test Signal	Max. Input
2nF	1pF	NC	3.5% + 4	400mV rms	3V DC/peak AC on all ranges
20nF	10pF			512 Hz 40mV rms	
200nF	100pF				
2000nF	1nF				
20μF	10nF				

METEX MULTIMETERS

These instruments are compact, rugged, battery operated, hand held 3½ digit multimeters. Dual-slope A-D converters use C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided.

METEX 3800 MULTIMETER

This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current. Resistance and Diode, for testing Audible continuity and transistor hFE. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features...

- Push-button ON/OFF power switch.
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- ½" high contrast LCD.
- Automatic over-range indication with the "1" displayed.
- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001".
- High Surge Voltage protection 1.5 KV-3 KV.
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
- Transistor hFE Test.

SPECIFICATIONS

Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0°C to +40°C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91530 **Normally $99.95**
SPECIAL $89.95

METEX 3530 MULTIMETER

This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, Capacitance, Transistor hFE and Continuity Test. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

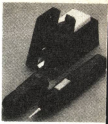
Features...

- Push-button ON/OFF power switch.
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- ½" high contrast LCD.
- Automatic over-range indication with the "1" displayed.
- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001".
- High Surge Voltage protection 1.5 KV-3 KV.
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
- Transistor hFE Test.

SPECIFICATIONS

Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0°C to +40°C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 **Normally $129**
SPECIAL $119



CORDLESS RECHARGEABLE SOLDERING IRON

- Built in solder point illumination
- Easy replacement of solder tip
- Protective stand which also functions as charging unit
- Sponge pad attach to stand
- Plug pack power adaptor
- Includes Nicad battery
- Instructtion manual
- 12 months warranty

Cat. T12480 .... Normally $79.95
SPECIAL, $69.95

WELLER WTCPN SOLDERING STATION

The WTCPN Features:

- Power Unit 240 V AC
- Temperature controlled iron, 24 V AC
- Flexible silicon lead for ease of use
- Can be left on without fear of damaged tips!

The best is always worth having.

Cat. T12500 .... **R.R.P. $149**
SPECIAL, ONLY $119

SCOPE 60W SOLDERING SYSTEM

- Infinitely adjustable temp. 200 C to 470 C. Sliding control selects desired tip temperature (LED readout monitors tip temp.)
- Safety holder features ceramic burn-proof bush and can be converted to left-hand-side.
- Soft and cool hand grip in pliable rubber.
- Screw type connector prevents accidental plug removal and guarantees solid contacts.
- Temperature lock allows production supervisors to control soldering temperatures.
- Anti seize tip retention design reduces risk of thread seizure by removing locking nut to cooler end of barrel.
- Optional 30W soldering pencil is available for finer work.

Cat. T12900 **Normally $159**
NOW $149

DIRECT IMPORT SOLDER SUCKERS!

Rod Irving Electronics has done it again! Quality solder suckers at incredibly low prices!!

REGULAR SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11271 .... **$9.95**

ANTISTATIC SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11281 .... **$11.95**

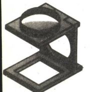
ARLEC SUPER TOOL

versatile 12V electric tool for...
- Sanding
- Engraving
- Grinding
- Polishing
- Cutting
- Drilling
- Milling
- Erasing, etc.

eatures:
perates on safe, low 12 volts from ains electricity via AC adaptor supplied). Light and easy to handle ith touch switch and lock for ontinuous running. High torque otor. 10,000 R.P.M. Can drill 2mm oles in steel. 2 year guarantee

ontents:
- 12V Super Tool
- Plugpack AC adaptor
- 1 spherical milling cutter
- 1 wire brush
- 1 grinding wheel
- 4 drill bits, 0.6, 0.8, 1.0, 1.2mm
- Set of 5 chuck collets
- 6 eraser sticks
- Instruction sheets

at. T12300 .... **$59.95**



FREE STANDING, FOLD P MAGNIFIER

n economically priced "hands free" agnifier, lets you take care of all ose tricky fine detailed jobs so ten encountered in electronics, or y of many other practical uses ch as home, work, hobbies etc.

at. T12083 **$14.95**

BELL WIRE

ed and white twisted
onductors: 2 x 1 strand 0.17mm
heath: O.D. 2 x 1.35mm
at. W

-9 rolls	10+ rolls
19.00/m	$17.50/m

COMPUTER CABLE

IC6 6 conductor computer terface cable. Colour coded with aided shield. o IE422 specifications). opper conductor 6 x 7/0.16mm.

-9 metres	10+ metres
1.90/m	$1.70/m

IC9.100 9 conductor computer terface cable. Colour coded with ylar shielding. 9 x 7/0.16mm.

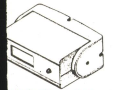
-9 metres	10+ metres
2.50/m	$1.95/m

IC12 12 conductor computer terface cable. Colour coded with ylar shielding. 12 x 7/0.16mm.

-9 metres	10+ metres
2.70/m	$2.50/m

IC16 16 conductor computer terface cable. Colour coded with ylar shielding. 16 x 7/0.16mm.

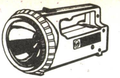
-9 metres	10+ metres
3.90/m	$3.40/m



PASSIVE INFRA RED ETECTOR

ompact P.I.R. with adjustable orner or wall mounting bracket, ual pyroelectric infra red sensing lement gives a coverage 2 x 14 ones 2m high and 10m wide.
- Sensitivity adjustment control
- Detecting range 12-15 metres at 90 degrees
- Detecting zones 9 long (up), 5 short (down)
- LED indicator for walk test. (can be disabled)
- Shielded against RF interference
- Relay output NC or NO at 30V (AC-DC) 0.5A max.
- Integral NC tamper switch
- Operating voltage 10.5 - 16V DC
- Current 20mA with LED 25mA

at. S????? **$145**



RECHARGEABLE LANTERN

- Up to 1,000 recharges
- No more expensive batteries
- Beam length 1,050 feet
- Cannot be over charged
- Shoulder strap included
- 240V charge lead connects direct
- 12V Car lighter recharging lead (ideal for camping, travel, boating etc)
- Red safety shade cover

Cat. A15053 .... **only $29.95**

RECHARGEABLE FLASH LIGHT

- Up to 1,000 recharges
- No more expensive batteries
- Beam range 150 metres
- Size: 160(L) x 60(W) x 60(H)mm
- Weight: 140 gram
- Shoulder strap included
- To recharge simply unclip the handle which contains the power pack and plug directly into a 240V power point.
- Charging time: approx. 10 hours (when fully discharged)
- Operating time approx. 80 minutes (when fully charged)
- Output/Bulb: 2.4V

Cat. A15052 .... **only $15.95**

RECHARGEABLE POCKET LIGHT

- Compact and very convenient!
- No more expensive batteries
- Up to 1,000 recharges
- To recharge, simply remove the rear cover and plug directly into a 240V power point.
- Charging time: approx. 15 hours (when fully discharged)

Cat. A15051 .... **only $13.95**

FLUORESCENT WORK & EMERGENCY LIGHT

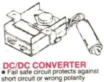
- Suits cars, boating, caravan, camping etc.
- Shatterproof, glare free
- Cigarette lighter plug and alligator clips
- 12V DC, 8 watt, transistorised

Cat. A15052 .... **$25.95**

FULLY AUTOMATIC EMERGENCY LIGHTS

In the event of a power failure these lamps will automatically come on. A very handy service, particularly where natural light is not available. The power meter is used to indicate recharging.

Cat. A15049 .... **$109**



DC/DC CONVERTER

- Fail safe circuit protects against short circuit or wrong polarity
- Under dash mounting
- 13.8V DC input
- 7.5/9/12V DC output
- Current: 7.5V (900mA); 9V (1.2 amp); 12V (1.2 amp)
- 2 metres cord with 4 plug adaptor

Cat. A15054 .... **$21.95**

LIGHTER TO LIGHTER CAR STARTER

The simple, cleaner solution to flat car batteries! Simply plug in to the cigarette lighter postions and presto! Features 5 metre long lead, and LED indicates correct connection

Cat. A15062 .... **$10.95**

DIGITAL SPEEDO/ DIGITAL TACHO/ SPEED ALERT

- Digital readout (LED) for both tacho and speedo.
- Alarm with sound at variable preset speed.
- Audible beeper and visual indicator.
- In built light indicator for night illumination.
- Designed for 12 volt negative earth electrical systems.
- Speedo: 0 - 199kph
- Tachometer: 0 - 9900kph
- Speed alert: 40 - 120kph
- Complete with mounting hardware.

Cat. A15064 **Normally $69.50**

SPECIAL, ONLY $59.50

CODE KEY PAD

- Telephone type digital keypad.
- Four digit, changeable code.
- Over 5000 possible combinations.
- Power consumption: 5mA standby, 50mA alarm.
- Two sector LED and 1 arm LED.
- Wrong number lockout.
- 12V DC operation.
- Relay output.
- Panic button.
- Normally open tamper switch.
- Dimensions: 145 x 100 x 37mm
- ACP3 compatible.

Cat. A13014 **Normally $69.50**

SPECIAL, ONLY $55.60

ECONOMY TRANSFORMERS

	1-9	10+
2155 240V 6-15V 1A Cat. M12155	$9.95	$8.95
2156 240V 6-15V 2A Cat. M12156	$14.95	$13.95
2840 240V 9V CT Cat. M12840	$5.95	$4.95
2851 240V 12-6V CT 150mA Cat. M12851	$5.95	$5.50
2860 240V 15V CT 250mA Cat. M12860	$5.95	$4.95
6672 240V 15-30V 1A tapped Cat. M16672	$14.95	$13.95

ELECTRET MIC INSERTS

With pins for easy board insertion.
Cat. C10170

1+	10+	100+
$1.95	$1.70	$1.50

3½ DIGIT ECONOMY LCD DPM 50

- **Ultra-Low Power**
- **Bandgap Reference**

An ultra-low power, extremely stable LCD CPM suitable for a wide number of different applications. Features Auto-zero, Auto-polarity, 200mV fsd, User adjustable Low Battery indication, 12.5mm digit height, programmable decimal point. The QP-5513 has an external bandgap reference for extra temperature stability, with connections brought out, allowing use in single ended, differential or ratiometric mode. The fsd can be easily rescaled by the user to indicate volts, amps, ohms or many other engineering units. Supplied with a beezel mounting, clips, connectors and full data sheet.

SPECIFICATIONS:
Accuracy: 0.1% + −1 count
Linearity: + −1 count
Samples/sec: 3
Temp. Stability: 50 ppm typical
Temp. Range: 0 - 50∘C
Supply Voltage: 5 - 15V DC
Supply Current: 200uA typical
Max. DC Input Voltage: + −20V

Cat. Q15513 .... **$79.95**

AUSTRALIAN MADE!

DIECAST BOXES

Diecast boxes are excellent for RF shielding, and strength. Screws are provided with each box.

H11451	100 x 50 x 25mm	$ 5.95
H11452	110 x 60 x 30mm	$ 6.50
H11453	120 x 65 x 40mm	$ 6.95
H11461	120 x 94 x 53mm	$11.50
H11462	188 x 120 x 78mm	$13.50
H11464	188 x 188 x 64mm	$29.50

"SNAP TOGETHER" PLASTIC CASE

Top and bottom simply snap together (no screws required), removable front and back panels.
Size: 186(W) x 125(D) x 50(H)mm

Cat. H10116 .... **$7.95**

HOOK UP WIRE

Cat. No. Description
W11251 13/.12 TND BLK
W11252 13/.12 TLD BROWN
W11253 13/.12 TLD ORANGE
W11254 13/.12 TLD YELLOW
W11255 13/.12 TLD GREEN
W11256 13/.12 TLD BLUE
W11257 13/.12 TLD WHITE

PRICES PER 100 METRE ROLL

1-9	10+
~~$5.95~~	~~$5.00~~
$5.35	$4.50

W11260 14/.20 RED
W11261 14/.20 BLACK
W11265 14/.20 BLUE
W11268 14/.20 WHITE

PRICES PER 100 METRE ROLL

1-9	10+
~~$12.00~~	~~$10.00~~
$10.80	$9.00

W11270 24/.20 RED
W11272 24/.20 BLACK
W11274 24/.20 GREEN

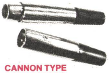
PRICES PER 100 METRE ROLL

1-9	10+
~~$14.00~~	~~$12.00~~
$12.60	$10.80

W11280 32/.2 BROWN
W11282 32/.2 BLUE

PRICES PER 100 METRE ROLL

1-9	10+
~~$20.00~~	~~$18.00~~
$18.00	$16.20



CANNON TYPE CONNECTORS

Cat. No.	Description	Price
P10960	3 pin line male. Was $3.90	NOW $2.90
P10962	3 pin chasis male Was $3.00	NOW $2.40
P10964	3 pin line female Was $4.50	NOW $3.25
P10966	3 pin chasis female Was $4.95	NOW $3.45

PUSH BUTTON DIALLERS

Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number redial (up to 16 digits) and instructions for an easy changeover.

Cat. A12030 . **NORMALLY $19.95**

SPECIAL, ONLY $14.95

ALWAYS CHECK OUR MEMORY PRICES BEFORE YOU BUY!! (If you find a cheaper price let us know!)

IC SPECIALS!

	1-9	10+	100+
555 8pin	0.50	0.40	0.35
4116	$3.95	$3.75	$3.50
4164	$3.95	$3.75	$3.50
2716	$8.90	$8.50	$8.30
2732	$8.25	$7.95	$7.50
2764	$6.25	$5.95	$5.00
27128	$6.95	$6.50	$6.25
6116	$2.95	$2.75	$2.50
41256	$5.95	$5.50	$4.95
6264	$6.50	$5.50	$5.25
27256	$11.50	$10.50	$10.00

WORLD MODEM CHIP

Cat. U21614 Normally $49.50

Save $20, SPECIAL $24.95

MEL9501

Have you blown up your Apple drive by plugging it in backwards or not turning off the power while changing bauds? We have the MEL9501 chip!

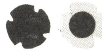
SPECIAL, ONLY $29.95

SPEECH SYNTHESISER CHIPS!

SPO256A-AL2: Speech synthesiser chip, needs programming to work.
.... **$16.95**

CTS256-AL2: Contains the code recognition circuit to enable the project to plug directly on the printer port, or into an IBM PC.
.... **$29.95**

A SET OF EACH . $44.95



POT CORES

FX2242 Assembly.
2 halves, 36mm diameter
L12100 .... $6.95

Former to suit FX2242
L12101 .... $0.95

FX2243 Assembly.
2 halves, 24mm diameter
L12110 .... $7.95

Former to suit FX2243
L12111 .... $1.00

E Core. 2 halves
L12115 .... $6.95

Former to suit E Core
L12116 .... $3.95

Complete E Core assembly.
(including end plates and bolts)
L12117 .... $12.95

HIGH INTENSITY RED LED BAR GRAPH

Dimensions:
Overall: 63mm across, 5mm high.
LEDs: 10 x 5mm x 1mm
Cat. Z10180

1-9	10+	100+
$2.95	$2.75	$2.50

ULTRASONIC TRANSDUCERS

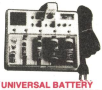
Designed to transmit at 40kHz (L19990) and receive at 40kHz (L19991) with up to 20V I/P on the transmitter. These units can't be heard and so are ideal for TV remote controls, water level detectors, burgalar alarms, motion detectors and information carriers as they can be either pulsed or used in the continuous wave mode.
Full specifications below for design purposes.

Maximum Input Voltage: 20V rms
Centre Frequency (kHz): 40 + −1.0
Sound Pressure Level 10V RMS:
110dB min.
Sensitivity (dB/v/ubar) min.:
−65 min.
Bandwidth (kHz):
Transmit: 4.0 (at 100dB)
Receiver: 5.0 (at −73dB)
Impedance:
Transmit: 500
Receiver: 5000

Cat. L19990 (Transmitter) . **$4.75**
Cat. L19991 (Receiver) **$4.75**

NICADS!

Size	Desc.	1-9	10+	100+
AA	1.2 A.H.	$2.50	$2.25	$1.95
C	1.2 A.H.	$7.95	$6.50	$6.25
D	1.2 A.H.	$7.95	$6.50	$6.25



UNIVERSAL BATTERY CHARGER AND TESTER

Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for D, C, AA, AAA, N, button and cell batteries, 9V and 6V (square types). Comes complete with detailed instructions.

Cat. M23533 .... **$29.95**

DELUXE UNIVERSAL BATTERY CHARGER AND TESTER

Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for up to 8 pieces of any size, (D, C, AA or AAA type batteries) at once, plus positions for a button and cell battery. Two times 9V, and one times N type batteries. Recharging lead with alligator clips, 9V clip and 4-way universal. Select currents from 2.5-3V 150mA, 1.2-1.5V 80mA, 1.2-1.5V 25mA, 6-9V 14mA, 12V 50mA. Includes detailed instructions.

Cat. M23535 .... **$39.95**

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Phone (03) 663 6151

425 High St, NORTHCOTE
Phone (03) 489 8866

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$200 – $499	$10.00
$500 plus	$12.50

This is for basic postage only. Comet Road Freight, bulky and fragile items will be charged at different rates.

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Registered Post for orders over $200 incuded free!

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Ph. (03) 543 2166 (3 lines)

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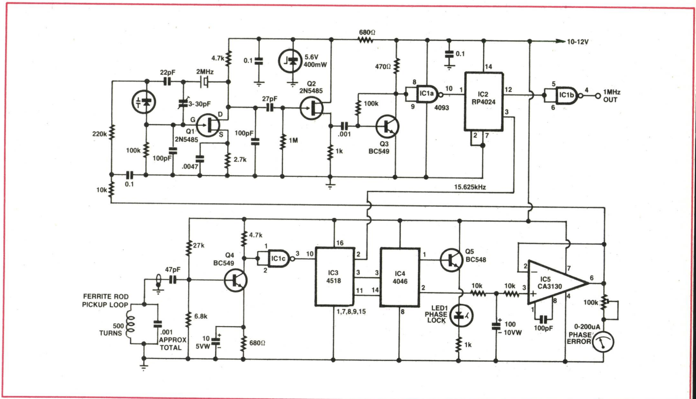
MasterCard VISA

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have n been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.



TV based frequency standard

It is possible to derive a highly stable frequency standard from a TV receiver. Indeed, some stations stabilise their line synchronising pulses with a rubidium standard which can have an accuracy of about one part in 100,000,000,000. Other stations use oven-stabilised crystal oscillators which are not quite as accurate but are nevertheless quite good.

In Sydney, both the ABC and TCN9 use the rubidium standard and thus their line synchronising pulses are highly accurate and stable. This circuit shows how to derive a jitter-free 1MHz reference frequency from these pulses.

Q1 and its associated parts form a 2MHz crystal oscillator. The output of this oscillator is fed via Q2, Q3 and IC1a to IC2 which is a 4024 7-stage binary counter. This divides the signal by two to give the 1MHz reference output at pin 12, and by 128 to give the TV line synchronising frequency of 15.625kHz at pin 3. The pin 12 output is buffered by IC1b to give the 1MHz reference output, while the pin 3 output is fed to pin 2 of IC3.

The remainder of the circuit provides feedback control for the crystal oscillator (Q1). It uses a ferrite rod loopstick to pick up the 15.625kHz line synchronising pulses from the TV receiver. This signal is then amplified by Q4 and applied via buffer stage IC1c to pin 10 of IC3.

IC3 is a 4518 dual 4-bit binary counter and is used here to divide the signals on its inputs by two. The resulting outputs have a 50% duty cycle at pins 11 and 3 and are fed into the IC4, a phase lock loop IC which is used simply as a phase comparator. The resultant error voltage appears at pin 2 and is fed via a filter circuit to voltage-follower IC5.

The output at pin 6 of IC5 is then fed back to the BA102 varicap diode in the crystal oscillator to phase lock it with the TV line sync pulses. Q5 turns on and lights LED 1 when the lock condition is achieved.

Before putting the frequency standard into service, the following steps need t be taken. After switching on:

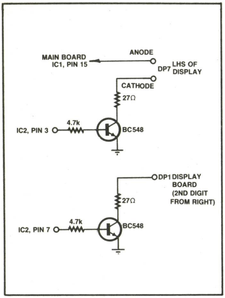
1. Adjust the 100k trimpot in series with the meter so that it reads exactly centre-scale.
2. Adjust the frequency of the crystal oscillator to zero-beat against WWV, VNG or some other suitable reference.
3. Adjust the resonant frequency of the pickup loop to 15.625kHz. Whilst not critical, this will improve the sensitivity.

The unit is now ready to be synchronised with the TV receiver. Note that sufficient pick up must be obtained to light the "phase-lock" LED. The meter will then come to rest after several seconds, at or near to centre scale.

If necessary, centre scale may be obtained by fine tuning of the crystal oscillator trimmer. The 1MHz output will now be virtually as stable as the rubidium standard at the station.

I. Pogson,
Epping, NSW.

$25



Extra decimal points for EA DFM

The EA Digital Frequency Meter described in December 1981 had no decimal point included in the display. Switching between ranges thus often gave a confusing readout. This was largely overcome by the addition of a decimal point driving circuit, published in EA, July 1982. However, there were still two ranges which did not have the decimal point included in the display.

This simple modification provides the decimal point display for the remaining two ranges. One of the decimal points could not normally be displayed because it would have been located to the left of the most significant digit, and the FND507 displays have right hand decimal points only. However, the decoded output for this decimal point is actually available from the decimal point driver at pin 3 of IC2.

In this circuit, an NPN driver transistor is used to drive a discrete LED positioned at the left hand extreme of the display. The anode is connected to pin 15 of IC1 on the main board — this will become DP7.

The second missing decimal point (DP1) is between the two least significant digits. The decoded output for this is available from pin 7 of IC2 of the DP driver — again through an NPN driver transistor. The track to DP0 must be cut to prevent it from lighting as well.

Eric Rodda,
Marion, SA.

$15

Modified audio generator

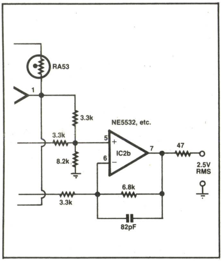
Several readers have contacted the designer of the high performance audio generator circuit published in the May 1986 CDI pages. Apparently, there is no source for the R54 thermistor used in that circuit, although the RA53 type is available from Radiospares Components (Part No. 151-114), 6c Durdans Ave, Rosebery, NSW 2018. Telephone (02) 669 3666.

The RA53 type can be directly substituted in the original circuit but the output level will be reduced to half its previous value. This problem can be overcome by modifying the output stage to provide a gain of two as shown in the diagram.

Readers are also advised that a standard dual-gang 10k potentiometer can be used in the circuit but try to find one where the maximum resistances of the two sections are within 10% of each other. Note also that if NE5534s are used, 22pF compensation capacitors between pins 5 and 8 are necessary. Finally, TL072 or RC4558 op amps can be substituted but with a slight increase in noise and distortion.

Phil Allison,
Summer Hill, NSW.

$10



Basic program for vented box enclosures

This short BASIC program for VZ computers will design the size of the vent needed in a bass reflex enclosure to tune it to a given frequency. It calculates the length of the vent from the given diameter, box volume and box frequency. Also the tuned frequency of an existing enclosure can be found from the cabinet volume and vent dimensions.

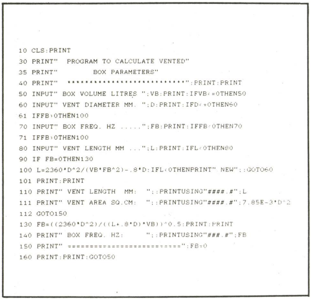
Surprising though it may be, the woofer size or type does not affect the tuned frequency; this means that you won't need any speaker data.

If the program gives a vent length of about 20mm then just a hole in the baffle is needed. Remember, however, that any vent should have a diameter not less than one quarter of the woofer diameter to prevent excessive air velocity.

For checking an existing design press RETURN when "BOX FREQ. HZ..." appears. This frequency is then calculated using the other data. If "NEW VENT DIAMETER MM. " appears, enter a new larger diameter and try again since the desired frequency cannot be achieved with the previous value.

Phil Allison,
Summer Hill, NSW.

$20



```
10 CLS:PRINT
30 PRINT"  PROGRAM TO CALCULATE VENTED"
35 PRINT"          BOX PARAMETERS"
40 PRINT"  **************************":PRINT:PRINT
50 INPUT" BOX VOLUME LITRES ";VB:PRINT:IFVB<=0THEN50
60 INPUT" VENT DIAMETER MM. ";D:PRINT:IFD<=0THEN60
61 IFFB>0THEN100
70 INPUT" BOX FREQ. HZ .....";FB:PRINT:IFFB<0THEN70
71 IFFB>0THEN100
80 INPUT" VENT LENGTH MM ...";L:PRINT:IFL<0THEN80
90 IF FB=0THEN130
100 L=2360*D^2/(VB*FB^2)-.8*D:IFL<0THENPRINT" NEW";:GOTO60
101 PRINT:PRINT
110 PRINT" VENT LENGTH  MM:  ";:PRINTUSING"####.#";L
111 PRINT" VENT AREA SQ.CM:  ";:PRINTUSING"####.#";7.85E-3*D^2
112 GOTO150
130 FB=((2360*D^2)/((L+.8*D)*VB))^0.5:PRINT:PRINT
140 PRINT" BOX FREQ. HZ:      ";:PRINTUSING"###.#";FB
150 PRINT" ==========================":FB=0
160 PRINT:PRINT:GOTO50
```

WHAT DESTROYED

There were many factors behind the destruction of the space shuttle "Challenger". This article provides a fresh insight into the disaster. It probes the causes and describes how NASA might have better assessed the risks.

NASA, progenitor of American icons and keeper of the faith that man's destiny lies in the stars, is in trouble. It's not so much that, 73.621 seconds after launch on Jan. 28, the shuttle *Challenger* was destroyed by an horrific explosion that killed the spacecraft's seven occupants. Or that one of the victims was NASA's first "civilian" passenger, Christa McAuliffe, 37, a high school social studies teacher from Concord, N.H. As distressing as those facts are, even more damaging for NASA, which over the past 25 years has established an unmatched reputation for technical excellence, is that the explosion happened by surprise. All mechanics understand that machines aren't perfect; that's why good ones pride themselves on taking special care with things that might break.

And although other kinds of accidents involving machines — airplane crashes, for example — may result in more fatalities, the shuttle catastrophe had far greater significance. In the short term it resulted in a national upwelling of grief. In the long term it has broad political implications for the agency — and the space program. For some members of Congress, NASA offers the same satisfaction of buying exotic equipment that the Pentagon does, but without the bloody implications. For a president, NASA is a public relations mother lode; in Ronald Reagan's case, it allowed him, for example, to stake out a pro-education position by announcing that a teacher would be the first "civilian" in space, even while he slashed allocations for schooling. Although the public tends to ignore these less than noble relationships, they're potent. And if they sour, Washington will react in the traditional manner: cutting its losses in a way that could turn NASA into a second-class bureaucracy.

In assessing the damage, the engineering questions must come first, because it's in the answers to them that both the causes of the accident and NASA's level of responsibility for it will be found.

"Whenever a rocket goes up successfully, it's a miracle," says Robert Cooper, an engineer and businessman who until last summer directed the Pentagon's Defense Advanced Research Projects Agency."I've been involved with launching hundreds of them — something always happens that makes you think they'll never work again."

That Cooper should still speak in religious terms about a process that most Americans have come to regard as the embodiment of high-tech maturity is an indication of how far out on a limb NASA went — or was driven — with a dangerous machine.

The presidential commission investigating the *Challenger* disaster hadn't reported its findings by this writing, but speculation, both before the committee and among engineers, on the cause of the accident had become focussed on the failure of the seal between the two aftmost sections of the shuttle's right solid-fuel booster. This 45.4 metre-long rocket, one of two that produce 1.5 million kilograms of thrust each, is an assemblage of eleven weld-free, circular steel casings about 3.7 metres in diameter that are joined into four segments. The 1.3cm thick segments are connected to one another by tongue-and-groove joints that are secured by 177 steel pins. If these joints aren't sealed properly, then gases from the propellant burning at 3,000 degrees C inside the booster can escape and cause catastrophic damage.

WHY build the booster in segments, which would seem to be a plumber's nightmare? "All big solid rocket boosters are done this way," says Cooper. "It's not possible to grow a propellant grain that's larger than a certain size and still

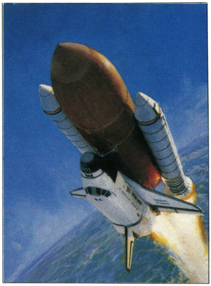
SPECIAL REPORT

The immediate cause of the disaster may have been a faulty seal, but a deeper reason may be that, because of economic and political pressures, NASA sacrificed safety standards

by WAYNE BIDDLE

CHALLENGER?

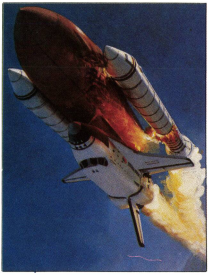
11:38:59.259

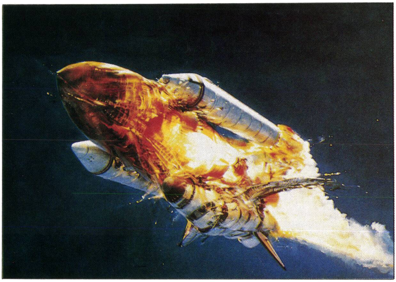


In this depiction of how the accident may have unfolded, fire erupts by the right booster's aft seal and burns away the attachment between the booster and the fuel tank.

11:39:12.8

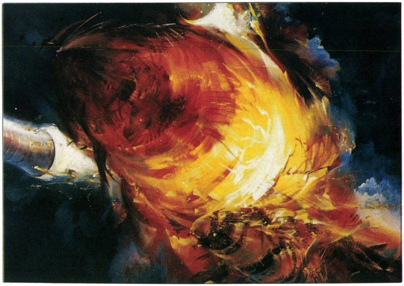
The fire now encircling the booster burns away the attachment between the booster and the fuel tank.





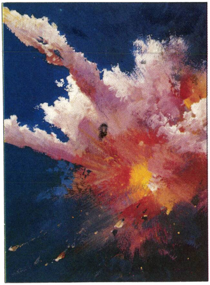
11:39:13.631

Perhaps because the booster nose is now free to pivot into the tank, a vast explosion is set off in the tank.



11:39.14.0

The explosion, fueled by the highly volatile mix of hydrogen and oxygen in the tank, destroys the orbiter.

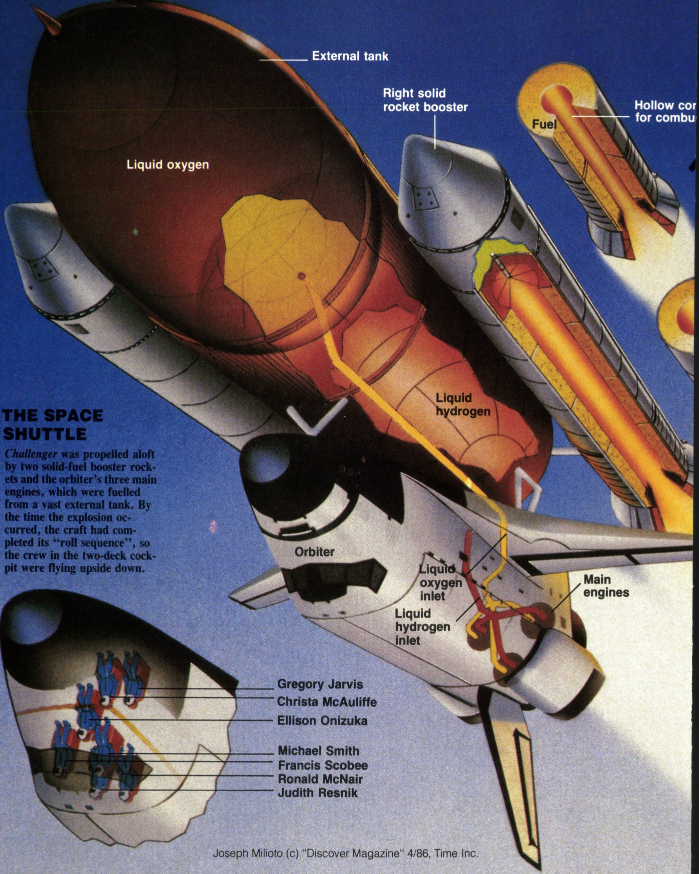


11:39:25.0

The wrecked *Challenger* disappears behind a ball of fire and a cloud of vapour, as the boosters fly on.

Paintings by John Berkey © "Discover Magazine" 4/86, Time Inc.

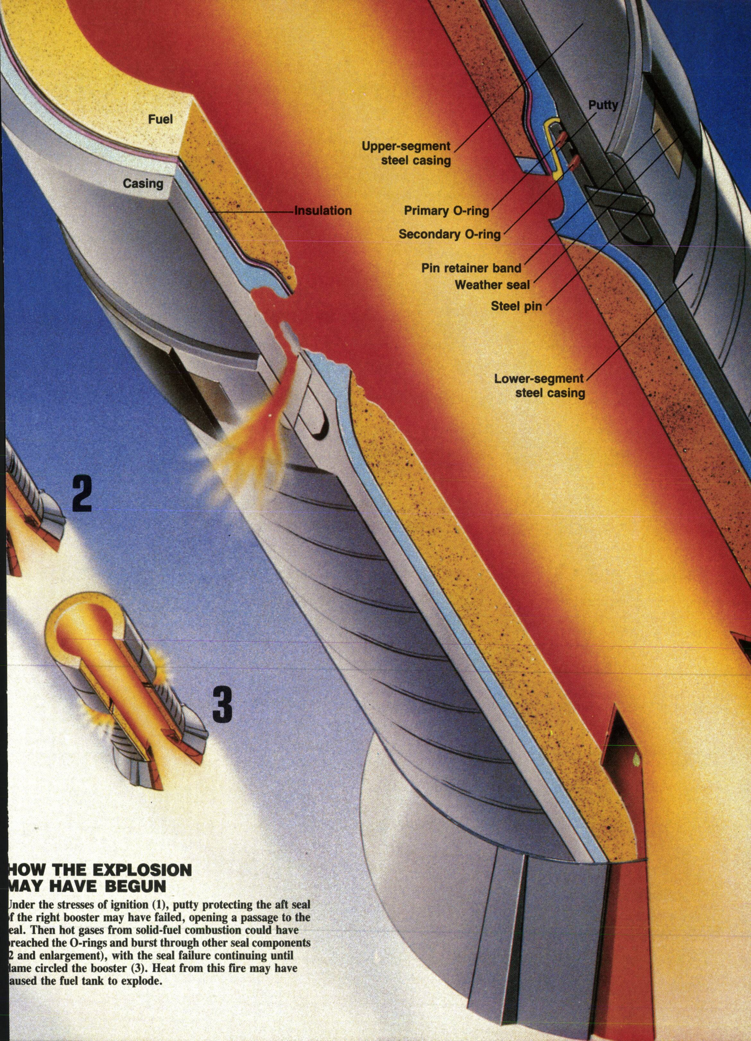
CHALLENGER'S FATAL FLAW



THE SPACE SHUTTLE

Challenger was propelled aloft by two solid-fuel booster rockets and the orbiter's three main engines, which were fuelled from a vast external tank. By the time the explosion occurred, the craft had completed its "roll sequence", so the crew in the two-deck cockpit were flying upside down.

Joseph Milioto (c) "Discover Magazine" 4/86, Time Inc.



HOW THE EXPLOSION MAY HAVE BEGUN

nder the stresses of ignition (1), putty protecting the aft seal f the right booster may have failed, opening a passage to the eal. Then hot gases from solid-fuel combustion could have reached the O-rings and burst through other seal components 2 and enlargement), with the seal failure continuing until lame circled the booster (3). Heat from this fire may have aused the fuel tank to explode.

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WHAT DESTROYED CHALLENGER?

guarantee uniformity." "Grow a propellant grain" is engineer-talk for the manufacturing process whereby chemicals — in this case a mixture of 70% ammonium perchlorate, 16% powdered aluminium, a binder called polybutadiene acrylic acid acrylonitrile terpolymer (12%), an epoxy curing agent (2%) and a trace of iron oxide — are poured into the steel segments. In the case of the shuttle's boosters, this propellant load is built up in about 40 pourings, then cured and groomed for uniformity. The segments are then stacked.

At least since 1980, NASA has recognised that the integrity of the seals between casing sections is a troublesome safety issue. For example, on a "critical items list" compiled by an agency analyst and dated Dec. 17, 1982 — after five successful shuttle missions — the potential effect of a seal failure was described with chilling terseness as "loss of mission, vehicle and crew due to metal erosion, burn-through, and probable case burst resulting in fire and deflagration." By April 1984 there was enough concern that NASA managers ordered a formal review of the sealing procedures.

There were good reasons for such scrutiny. Out of the first twelve shuttle flights, inspection of retrieved boosters had revealed four instances in which the first of two rubber gaskets, or O-rings, which are major components of these seals, had been partly burned away by propellant gases in the joint between the nozzle and the aft segment. After NASA began using a new type of putty to protect the joint, such O-ring erosion happened even more frequently — seven burnings occurred in the first four flights of 1985. More troubling was the discovery of damage to a secondary O-ring in a nozzle joint on flight 51-B, which was launched on April 29 last year.

NASA officials have also observed at least half a dozen damaged primary O-rings on seals between the booster segments. These gaskets are meant to be "dual redundant" to ensure the utmost safety — damage to both meant that the double barrier was being breached. NASA realised that redundancy couldn't be guaranteed, and it waived its fail-safe rule for the O-rings in 1983. This is the sort of seal that may have failed on *Challenger*.

Test data submitted on August 19, 1985 to NASA by Morton Thiokol Inc., the manufacturer of the boosters, indicated that from 330 to 600 milliseconds after the fuel was ignited at launch, there was a "high probability of no secondary seal capability." During the next two minutes, while the fuel burned itself out as the shuttle hurtled upward, "if erosion penetrates the primary O-ring seal, (there is) high probability of no secondary seal capability," Morton Thiokol warned.

Nonetheless, NASA's top engineers and managers judged that this flaw wasn't serious enough to halt or delay shuttle flights. "The current design must be improved," a NASA engineer advised NASA's chief of propulsion systems in July 1985. "The long-term steps will require design and procedure changes that will require expensive qualification."

A launch chronology released by NASA showed that *Challenger's* right-hand booster emitted a puff of dark smoke from the vicinity of its aft casing joint at 0.445 seconds after ignition, indicating that the seal had failed. By the 2.147 second mark the smoke had billowed halfway across the booster and remained visible until about twelve seconds into launch. For the next 45 seconds or so, the shuttle system operated smoothly despite the presumably blown seal. The ascent into orbit is totally automated, with the shuttle "pilots" available for limited duty only in dire emergencies.

In this case, although the shuttle's sensors were recording information of relevance to the impending disaster, it was being stored as usual for later reference and not relayed directly to the crew or ground controllers. Even if someone had known about the blown seal, however, there's no escape from the shuttle while the solid-fuel rockets are firing.

Ominous data being recorded by the sensors wasn't being relayed to the shuttle's crew

At 58.774 seconds came the first sign that the right booster was about to fail — smoke from the casing just above its aft attachment to the vast liquid-fuel tank. This was about the time when pressure inside the booster began its normal rise after having fallen from the peak that occurs at ignition. At 59 seconds the shuttle experienced the maximum level of aerodynamic stress. At 59.249 seconds, an intense tongue of hot gas appeared on the booster casing, indicating that the seal had cracked wide open.

With propellant gas roiling from the side of the booster as well as out of its nozzle, internal pressure started to fall to below that of the left solid rocket, which was running properly. Sensors noticed this mismatch at 60.164 seconds, but it wasn't great enough yet to cause alarm. The boosters are never precisely alike, and some thrust deviation is expected.

BUT now the flow of gases through the seal crack was thrusting in a direction the spacecraft's structure couldn't tolerate. At 62.484 seconds, onboard computers commanded *Challenger's* right wing elevon to move as part of a vain effort to correct this imbalance. Another attempt to keep the flight path true came at 63.924 seconds, when the computers ordered the orbiter's right engine nozzle to pivot.

At about 66 seconds, other hot spots began to appear on the forward casings. At 67.684 seconds, sensors noticed a pressure glitch in the line feeding liquid oxygen from the external fuel tank to the orbiter's engines, suggesting that the tank was coming apart. At 73.175, a gas cloud suddenly appeared beside the tank, and then there was a flash between the orbiter and the tank's liquid hydrogen chamber. The vehicle started to break up, with an explosion near the booster's forward attachment strut to the tank occurring at 73.226.

Budget and performance pressures may be more than NASA can withstand

One theory about the cause of this explosion was propounded by *Aviation Week & Space Technology*, which hypothesised that heat from the fire had destroyed the aft attachment between the booster and the tank. The nose of the booster then pivoted to the left, piercing the thin skin of the tank.

At this point, as the shuttle stood on the edge of eternity, two poignant events took place — one demonstrating the durability of a machine, the other the instinct of a man. At 73.534 seconds, 87 hundredths of a second before all data ceased in a fireball, computers began to shut down the orbiter's engines because of overheated fuel pumps. A voice tape of the flight carries the sound of an explosion just before the end of transmissions at 73.621 seconds, meaning that Shuttle Commander Dick Scobee had probably turned on his microphone to ask controllers why the shuttle was jolting left and right.

The implications of a design change in a machine as complex as the shuttle are profound. There's no such thing as tinkering. Putting the system together took a decade of tests to certify not only every component but also the interplay among them. According to Richard Cook, a NASA budget analyst, it would take 13 months just to get redesigned casings back from the manufacturer once a new seal had been approved. Lawrence Mulloy, the shuttle project manager for solid-fuel boosters, says modification of the O-ring joint could take anywhere from four months to three years. "Merely qualifying a new putty for the joint — something that was under way before the *Challenger* accident because of the seal erosion and because the existing caulking contains asbestos and is hazardous to workers — would cost $50 million", says Cook.

ACCORDING to documents released by the presidential commission, NASA had long been aware of how the case seal could fail. At the moment of booster ignition, rapid internal pressure build-up causes tiny blowholes through the zinc chromate putty that protects the joint from hot propellant gases. These holes permit unwanted pressurization of the empty cavity between the spot where the putty ends and the first O-ring, as well as direct erosion of that O-ring by the gases. Rotational stess at the joint during launch can unseat the gaskets.

The O-rings are made from a fluorocarbon elastomer, which has good resistance to high temperatures but not as much sealing resilience as other types of rubber. This lack of resilience worried members of the commission, because the cold at the time of *Challenger's* launch — 3.3 degrees C versus 11 degrees for the previous coldest launch — could make the rubber stiffen. There were reports that during one of the commission's closed hearings, a high-level Morton Thiokol engineer had testified that he'd argued strenuously with company and NASA officials that *Challenger* shouldn't be launched because of the effects of cold on the O-rings. His views, however, weren't made known to those with the authority to scrub the lift-off. The commission also heard that on the morning of the launch temperature-sensing devices, which are of questionable reliability, had recorded surface readings on the right booster as low as -14 degrees C. The head of the shuttle program was never told of these readings.

More alarming than NASA's decision to send *Challenger* aloft in the cold was its failure to ensure that the above information reached its top officials. Though at this writing there was still substantial dispute among technical experts about what, if anything, the cold may have done to the O-rings, there was no doubt that the seals had long been a source of concern, and any information about them should have been given top priority. But NASA treated these warnings no more seriously than it had earlier ones from its engineers and Morton Thiokol.

In reaction to the evidence of seal erosion, Morton Thiokol submitted 43 design revisions for NASA's consideration last August. The company warned then that the joint that apparently led to *Challenger's* destruction "poses the greatest potential risk in that its secondary seal may not maintain metal contact". NASA was to have begun testing a modification of the backup seal this year, but decided to keep flying the shuttle in the meantime.

"If you fix something like this, you've got quite a range of cost implications," Cook told the commission, calling the process a "major budget hit".

That money was apparently a consideration in a safety debate is the most unsettling revelation of the aftermath of the *Challenger* disaster. Budget pressures have been a fact of life for the shuttle program since its birth in the early 1970s. Throughout the 1980s allocations for NASA have remained flat; as a result, the ever-rising costs of the shuttle program squeezed out much of the science and engineering research that's supposed to be the agency's main function. In 1984 NASA's Aerospace Safety Advisory Panel warned: "It is essential that the important objective of achieving a more cost-effective operation ... not be permitted to introduce unacceptable risks to the shuttle crew".

The panel's latest report, released on Feb. 12, contains no mention of the booster seals. Staff director Gilbert Roth says panel members heard testimony on the issue, but "must have been satisfied with agency work on the problem". The report does raise questions about whether proposed lightweight boosters made from so-called composite materials, or plastics, would be able to withstand the stress of launch.

The prospective move to plastic casings reflects another pressure on the shuttle system — greater payload obtained by lowering the vehicle's weight — that the safety panel has repeatedly warned about. Before the sixth shuttle mission, each booster weighed about 83,915 kilograms when empty. Shaving the thickness of the steel casings by 0.5 to 1 millimetre brought the weight down to 82,100 kilograms. Since higher-performance rocket motors were also added beginning with the eighth mission, the net effect was to increase the amount of cargo the shuttle can haul.

The same dictum — less weight, more cargo — has been applied to the other two primary shuttle components, the external liquid-fuel tank and the orbiter. With its sixth mission, the shuttle began to use a tank that, at 30,300 kilograms, was 4,128 kilograms lighter than its predecessors. The reduction was accomplished by getting rid of structural stiffeners, modifying internal frames and milling the tank walls thinner. Also, a lighter and cheaper titanium alloy was used in the tank's aft attachment struts to the solid-fuel boosters.

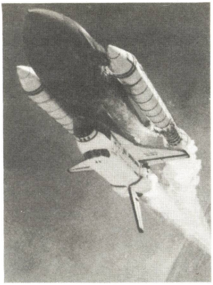
As for the orbiter, stresses in early flights were higher than predicted. In the first five missions the predicted limit of strain on the orbiter wings was exceeded 63 times during ascent and 41 during descent. NASA therefore had to reinforce the lighter wings of the third and fourth orbiters *(Discovery* and *Atlantis)* in 1984.

PUT simply, budget and performance pressures on the shuttle may have added up to more than the program could stand and still maintain adequate margins of flight safety. If so, then failure of a booster was just one of several catastrophes waiting to happen.

The NASA safety panel reports point to the strongest candidates. Last year, for example, the panel was especially critical of the orbiter's three liquid-fuel rocket engines. They've fallen short of the power levels they were expected to provide, and they have a voracious appetite for spare parts.

Still, the engines represent a considerable accomplishment; their most glorious feature is that they can be ignited, throttled up and down, extinguished, and restarted. No other rocket has ever been capable of this. Each engine produces 178,625 kilograms of thrust at 104 percent of rated power, the peak level during each mission so far. The two turbopumps that make it possible to get so much power out of such small engines are each the size of a trash can, yet each delivers the equivalent of 3.3 million kilowatts (five million horsepower).

The engines were supposed to last for 55 missions without extensive refurbishment. But the turbopumps have been far less durable than planned, and have sometimes had to be replaced after just two flights. Moreover, the engines haven't been cleared for routine use at 109 per cent of rated power, which is badly needed for carrying some military payloads into polar oirbit. "The accumulated data on turbomachinery has made it amply clear that the engine is being operated near the upper limits tolerable to the design", the panel warned.



NASA's hubris may have been exposed by its decision to take "civilians" on the shuttle

The proceedings of the safety panel, along with the internal documents released since the *Challenger* investigation began, seem to show that NASA was aware of how dangerous its spacecraft was. The outstanding question is why the program kept accelerating in the face of this information — more flights, less turnaround time, fewer dollars for engineering development. Small wonder the commission said the decision to launch *Challenger* may have been "flawed", and ordered that any NASA official involved in that decision not be allowed to participate in the post-mortem.

"I just hope that people realise that these things are all judgment issues," says Cooper in NASA's defense. "Every one of them has to be judged on its merit and with the knowledge the engineers have about how things fail. You do it every time you launch, every time you design a new system. It's a risky business".

RISKY business is what test pilots thrive on. But NASA's fatal hubris may have been most clearly exposed in the decision — or in acquiescence to a presidential suggestion — to take members of Congress, teachers, and journalists aboard. The image of Christa McAuliffe in orbit, teaching rapt children on earth, somehow became stronger to NASA than the engineers' knowledge of how things fail. What's left is an equation between imagery and substance that NASA will struggle to balance for years to come.

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The Serviceman

A wink is as good as a nod...

A serviceman's problems are not always purely technical. Particularly where warranty jobs are concerned, one often has to make a decision as to whether a claim can be justified. And, while most such cases are fairly clear cut, there is always the odd one about which there is an element of doubt. These can cause a certain amount of worry, especially where a substantial sum of money is involved.

My main story this month concerns just such a decision and, even now, there may be some doubt as to whether I made the right one. On the other hand, the customer is delighted and the company concerned has accepted the situation, so it is only my conscience that seems to be worried. And no nasty remarks about servicemen having no conscience!

The appliance involved was an AWA/Mitsubishi colour TV set type C6334, fitted with an MV100 series chassis. It was nearly four years old when this latest incident occurred — a matter of some importance, as we shall see — but I had made one previous service call to it, under warranty, when it was about two years old.

On that occasion the customer had complained of poor colour and a visit to his home confirmed that all was not well. More specifically, turning down the colour revealed a distinct greenish tinge. I pulled the back off and went through the colour balance/grey scale procedure, and this produced a first class picture. This point is of some importance in regard to later events, but it should be noted that both the customer, who is quite fussy about picture quality, and myself examined the picture most carefully before mutually agreeing that it was virtually perfect.

When the customer complained more recently it was in somewhat similar terms, ie, poor picture quality, but he went on to say that he thought the picture tube might be on the way out. Recalling the previous problem I was more inclined to think that it might be nothing more than another shift in colour, and which could be fixed in the same way.

Different symptoms

In fact, the symptoms turned out to be quite different. The first thing I noticed, as the tube warmed up and for several seconds afterwards, was that the overall picture quality, or definition, was extremely poor. Even though this cleared fairly rapidly, my first reaction was that the tube might be gassy. Thermionic devices in general may suffer in this way, in that the gas which has seeped in during the off period will affect performance at turn-on and until it has been burnt off by the heat of the cathode, and at some cost to cathode life.

On the other hand, I considered that it could be simply weakened cathodes which were taking more time than usual to reach full emission. Or it could be both, one being the fault of the other. But this was incidental to the customer's complaint. As he pointed out, wherever the picture contained a substantial area of red, particularly if it was saturated, the colour would smear to the right. The customer agreed that it had not been in evidence when I serviced the set previously, but went on to say that it had first been noticed some time after that, in a very mild degree, and had become progressively worse.

So everything pointed to a picture tube which was on the way out, and with only a few months warranty left. Nevertheless, I wasn't prepared to rush in and claim a new tube until I had exhausted any other likely possibilities. The Christmas break intervened at that stage, so I left the set with the customer for the time being. With the Christmas rush over and as soon as I could organise a loan set, I brought the faulty set back to the shop.

It produced the same symptoms on the bench as I had already observed, including the sluggish behaviour at warm-up. I gave the tube and associated drive circuits a thorough voltage check, determined to make sure that there was nothing wrong with the tube operating conditions which would contribute to either symptom. This included the tube heater voltage which, being derived from a winding on the EHT transformer, cannot be measured accurately with an ordinary multimeter.

But I could find nothing wrong. I let the set run on the bench for several days, mainly to convince myself that the red smear was really serious enough to justify a claim, if it came to that. The point was that, subjectively, the effect varied with picture content. On dilute colours, such as light studio flesh tones — news readers etc — it was possible to find an acceptable compromise colour control setting, whereby the effect was hardly noticeable.

But if such a scene was followed by one containing a highly saturated red, the smear effect was quite objectionable. Again, it could be minimised by resetting the colour control, but only at the expense of adequate colour saturation, which would become most evident when the picture reverted to the studio news reader scene. In broader terms, any abberation which calls for that kind of control juggling cannot be tolerated.

Finally, after I had tried every trick I could think of, and drawn a complete blank, I decided it was time to call for help. I rang the AWA service department and spoke to a staff member who had proved most helpful in the past. Having outlined the problem my first question was whether they had ever encountered anything like this smear problem and, if so, whether it was likely to be a picture tube fault.

The answer was quite definite; they had never seen anything like the problem as I described it and were quite unable to say whether it was likely to be a tube problem or not. Next question: in view of my suspicions about the tube, in regard to both the red smear and the sluggish warm-up characteristic, would they consider replacing the tube under warranty?

The reply was a little more subtle this time. "From what you tell me, the warranty on the tube has almost expired. If you want to make a claim, you ought to make it without too much delay."

Well, I reckon I'm old enough to recognise that a twitch of the eyelid is as good as a slight inclination of the cranium in the direction of an equine quadruped devoid of it's visionary capacity*. I took the hint and ordered a replacement tube under warranty.

This duly arrived and I set about fitting it to the set. That done, the next thing was convergence and colour balance adjustment. I concentrated on the convergence first, and deliberately avoided touching any of the colour balance adjustments. The convergence routine is rather tricky on this model set, being essentially mechanical, and involves juggling the scan coils around the tube neck and wedging them in place.

That done, I was able to confirm what I had already begun to suspect; with the colour turned off there was a marked colour cast in the picture. This was unusual in the circumstances or, at any rate, it would have been unusual had the original tube been in first class condition. On the other hand, it is quite common in cases where a tube has been flogged as long as possible with repeated colour balance adjustments. All of which seemed to confirm that, red smear aside, there was something suspicious about the original tube.

But that was somewhat academic at this stage because, after I had completed all the adjustments, and was able to take a long hard look at the end result, I was forced to the realisation that the red smear was still in evidence. I couldn't be sure, on a purely subjective basis, whether it was as bad as before, and rather imagined that it wasn't. However, that was probably wishful thinking because, after living with the set for a few days, I concluded that it was much the same as before.

So where did we go from here? My only previous experience with a colour smear problem anything like this involved a Philips model for which a modification had been issued for the red driver stage. While this was a design problem, rather than a fault, recalling it set me wondering as to whether there could be a fault in this red driver stage, such as the transistor, Q651, a 2SC2688.

I had no spare of this type in stock but, fortunately, it was a simple matter to swap the red unit with one of the others. The only good point about this exercise was that the result was completely conclusive; no difference to the red performance whatsoever. So that squashed that theory. After that I spent a lot of time with the colour bar generator and the CRO trying to analyse where and how the effect was occurring. Unfortunately, it all proved fruitless.

In desperation I rang the AWA service department again, re-stated the problem, detailed all the things I had tried so far, and asked for any suggestions. They had no specific suggestions to offer, but we chewed the fat over the problem for some time, discussing and discarding several possibilities. The upshot was that we moved our thinking back to chip LC601, an M51393P. This is a 30 pin unit which performs a variety of functions, including sync separator, R-Y, B-Y demodulator, various amplifying and clamping functions, plus the matrix providing the signals to the red, green, and blue driver stages.

In particular, I was anxious to find out whether there was any history of trouble with this chip, either in general terms or in regard to this specific fault. The answer was no; it had been a particularly reliable device. So that was that, except that I promised to let them know when, and if, I found the fault.

A long shot

I went back to the circuit, thought about all the things I had tried, and finally admitted that I would have to change the chip, if only to prove the point one way or the other. The truth is I had skirted around this idea for as long as possible, if only because unsoldering a 30-pin IC is not something I undertake lightly. This the more so because, judging by it's history, it seemed like a long shot.

Nevertheless, I ordered a replacement and, when it arrived, set to with the solder sucker and removed the existing one. Then I fitted the new one, crossed my fingers, and switched on. And lo and behold, that was the answer. The set produced a perfect picture, with all signs of red smear completely eliminated. In fact, it was only then that I rea-

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lised just how irritating the original condition had been.

So that was that as far as the job itself was concerned, but not quite the end of the story. One of the first things I did was contact the technician in the AWA service department and tell him what I had found. He was just as surprised as I was, but thankful for the advice which, hopefully, may help someone else with a similar problem.

The next question, in my own mind, concerned the kind of fault in the IC which would cause this effect. The best suggestion I can offer is that, whatever the actual defect, it resulted in poor frequency response and/or phase shift in the red channel out of the matrix. Unfortunately, it would probably take a fairly elaborate laboratory set-up to confirm this theory. Suffice it to say that we now know that this fault can occur in this chip.

And finally, there is the question I raised at the beginning; was I justified in replacing the tube under warranty? While granting that the smear turned out to be a red herring — Ouch! Sorry about that — I am still convinced that the tube was sick; either gassy and/or suffering from falling emission. Maybe, assuming the smear fault had been fixed first, we could have flogged it along for a while longer, but I seriously doubt whether it would have enjoyed a typical life span.

So, all things considered, I feel that the customer was entitled to a new tube. On the other hand I didn't make the decision lightly and, if faced with a similar situation again, I would be just as cautious.

And now, if all the foregoing seems rather profound, here is something in a lighter vein. It is from one of my regular contributors, J.L. of Tasmania, and he calls it:

The things people do

From time to time the Serviceman has related some of the crazy things his customers have done to various pieces of equipment. Each of us has his own favourite twit; one that keeps us in jam money, but not everyone is game enough to write about them. I'm game, so here are some of the zany tales from my patch.

Like the one about the HMV 12613 colour TV set that came in this morning. It had a small red raster and distorted sound. The owner said "It just went like that last night", but I wondered.

Once inside the cabinet, I found that the horizontal adjustment slug had been screwed right out of the horizontal coil and the adjustment rod twisted until it broke. Then Mr Somebody had similarly broken the rod from the vertical hold trimpot.

Unable to get any more adjustment from the vertical hold, he put a screwdriver into the trimpot and twisted that until it broke. The height and linearity trimpots were accessible from outside the set, so they got the same treatment.

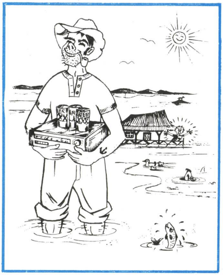
When none of his brutality produced any useful results, Mr Somebody must have removed the back cover and had a go at the screen adjusting pots on the tube base and the drive and sub-brightness trimpots on the chrome board.

When he had reduced an otherwise normal picture to the small red raster mentioned earlier, he decided that maybe I would be better able to fix whatever had started him on his destructive rampage.

After I had replaced the broken trimpots and put everything back to where it should have been, the set gave quite a good picture and seems not to have needed any real repairs in the first place. Like I said, money for jam!

Little glass valves

Something similar befell an AWA video recorder, model AV20. The owner arrived at tea time one Sunday evening and asked if I had one of those "little glass valves" for a VCR. The little glass valve turned out to be a fuse, a 1A delay type to be exact.



Now, fuses are not considered a user replaceable part in modern video recorders so I questioned him as to what had happened. You won't believe this!

It seems that his son was watching a rock'n'roll video and decided that the music was playing slow. From that, he deduced that the tape must be running slow, because the motor wasn't getting enough power. So he would give it some more.

He unscrewed the cover over the mains voltage adjustment and repositioned the plug at 110V. When he switched on there was a 'phutt' from inside the machine and "it didn't go any more". I can't imagine by what logic he arrived at the idea to readjust the mains voltage, but he sure gave the motor more power.

Anyway, Dad somehow decided that a fuse had gone so he took the cover off the machine and started poking around inside. He must have pretty sharp eyes because he spotted the blown fuse and tried to replace it with a 20A variety from his car. Fortunately, it wouldn't fit so that's when he came round to me. I had a suitable fuse, charged him for it, and he went off quite happily.

He was back next morning with the recorder wrapped in a blanket under his arm. When he unfolded the blanket I nearly cried. He had not bothered to put the cover back before wrapping it up and there were bits of blanket fluff all over the machine. This bloke was more than one sandwich short of a picnic.

Well, to shorten a long story, I decided that the job was really beyond me so I took it into town, to one of my more expert colleagues. It took him some time to find the fault which turned out to be one of those new fangled "solid state fuses" in one of the 12V supply rails. (It's a pity those things couldn't be made to change colour when they blow. They would then be a lot easier to find.)

Once the machine was running again, it was given a good going over and it was found to be running slow. So the young fellow had been right all along. A complete alignment of the capstan and drum servos put the machine back into first class order. But it cost the owner a lot more than one fuse to get it back again.

Vintage Jaguar

Another videorecorder story was less expensive for the owner but goes to show where some people place their priorities. This time an old but beautifully restored vintage Jaguar rolled up to the workshop. The owner unfolded himself from under the wheel and lifted an early model National top-loading VCR from the seat beside him.

In the workshop he showed me that the machine would accept a cassette, but then would do nothing with it. It wouldn't play, nor would it fast forward or rewind. It was even reluctant to give back the cassette. It would only open up after some gentle prodding with a screwdriver.

On the bench, I first removed the cassette holder cover, then the rest of the cabinet top. Once this was clear, the cause of the trouble was revealed. It was a beautifully detailed model vintage Jaguar car, about 10cm long.

It had fallen, or been pushed, in through the cassette carrier opening, and had lain among the works in such a position that it would stop things working without damaging them. It was the work of a moment to remove the model and check that the machine was now fully functional.

The surprising thing about this whole episode was the reaction of the owner. He seemed to care nothing about the recorder and the fact that it was undamaged. He was more distressed that his now recovered model car might have been scratched among the rods and levers in the VCR.

He seemed to value a plastic model car more highly than an expensive videorecorder and what he was going to do to that (expletive deleted) son of his when he got home was nobody's business.

I don't know! It takes all kinds . . .

The insurance fraud

Then there was something very funny (peculiar) about another job that came my way some months ago. It was a late model Pye stereogram and came in after a week of very heavy rain that flooded many homes in low lying areas.

The story that went with the Pye was that the basement rumpus room had been flooded and in the rush to move as much as possible upstairs the stereo had been dropped. The plate glass doors had been broken, the turntable had come loose and there were sundry other minor problems. The main worry was that the unit would not work at all now.

I was to give an estimate of the cost of repairs so that a claim could be made on insurance. This wasn't unreasonable at the time because we had been through a pretty harrowing period. But I changed my mind once I got inside the cabinet.

First up, there was no power in the set. I checked the fuse and found this OK so next I tried to check the transformer primary winding resistance from the power plug. There was no continuity because the transformer was wired between the neutral and earth pins. And yes, the active pin went to chassis.

Now there was no way this could have happened during a panic rescue from a flood, so I rang the owner and said, "What's goin' on?" "Oh, it's all right," he said. "When it wouldn't work after the flood, my mate had a look at it and fixed the plug for me."

I then asked if they had tried to use it after his mate's "fix" and, so help me, he said "Yes, the wife tried to play a cassette and it threw her across the room. That's when I decided that perhaps you had better have a look at it."

I told him there'd be no insurance claim on my reading of the facts and that if he wanted it repaired it would be at his own expense. In fact, the power transformer has an open circuit primary and the stereo output chip is shorted. I really wonder if it was in danger of being flooded. Or was the flood being used to get a cheap repair?

The four oddballs featured here are four out of many hundreds of regular customers. Fortunately, most people are perfectly normal and treat their audio gear, TV sets, and VCRs with respect. But somehow, they don't make such interesting reading.

Thank you J.L. for a most interesting contribution. I reckon those four will take some beating. As you suggest, the percentage of weirdos is small but, by crikey, what they lack in numbers they make up for in eccentricity. EA

**Translation: a wink is as good as a nod to a blind horse.*

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Philips K9 Chassis

Symptom: Two or three retrace lines at top of screen. No change when the height or linearity controls are adjusted.

Cure: C572 (100uF, 40V electro) open circuit. This cap forms part of the blanking network rather than the linearity circuit.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technicians' Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay, Tas. 7015.

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by GREG SWAIN

If you've having trouble making some of those distant QSOs (contacts) or just want more power for your HF rig, this new HF Linear Amplifier is the answer. Installed between your rig and the antenna, it will boost your power output by 10-14dB — up to a maximum of 150W PEP (peak envelope power) in fact!

This unit can be used on any HF amateur band between 1.8 and 30MHz and will pump out a good clean signal with better than 30dB rejection of unwanted harmonics. That's made possible by the use of switchable low pass filters, a feature often missing from commercial linear amplifiers.

The completed HF linear amplifier —150W PEP and switchable output filters.

In fact, some commercial units deliver a third harmonic content that's almost as strong as the primary frequency. Such units represent a significant potential source of radio frequency interference (RFI).

How much input power can you feed into the new linear amplifier? Answer: you can use any HF transceiver with a power output of up to 15W CW (30W PEP). The only proviso is that a 2:1 attenuator must be included during construction for transceivers in the 10-15W range.

Figs.1 and 2 plot the performance of the unit. As can be seen from Fig.1, the output power is generally better than 110W for an input of 10W from 1.8 to 24MHz. Above that figure, the power output drops due to the ferrite material used in the input and output transformers.

Even so, a power output of about 50W is still available at 28MHz for 10W input.

Let's now take a look at the front panel. There are just three operating controls: an on/off switch; a switch to select between AM and SSB operating modes; and the band filter switch. A power LED, an on-air LED and a power meter complete the front panel line-up.

The rear panel carries the input and output sockets.

Inside the amplifier are two relays which switch the unit in and out of circuit. When power is applied (ie, the on/off switch is in the 'on' position), the amplifier is switched into circuit by the relays whenever the press-to-talk (PTT) button on the transceiver is pressed.

When the PTT button is subsequently released, the amplifier is switched out of circuit and the relay contacts now connect the transceiver output "straight through"

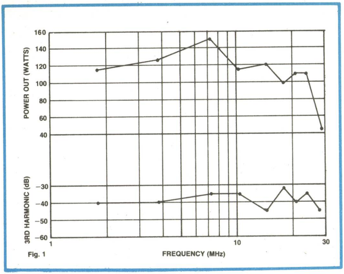


Fig.1: output power vs. frequency (10W drive).

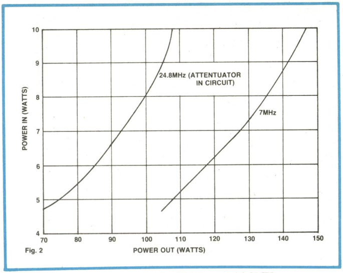


Fig.2: power out vs. power in for 7MHz and 24.8MHz.

to the antenna socket (on the back of the amplifier).

Finally, in addition to all of the above features, the unit is virtually "bulletproof". It is protected against reverse battery connection and battery overvoltage; it automatically shuts down in the event of RF overdrive; and it shuts down if the antenna SWR becomes excessive (eg, if the antenna lead goes open circuit).

How it works

Fig.3 shows the circuit diagram. It looks complicated but can be broken down into four easily understood sections: a power booster (Q101 and Q102); a low-pass filter circuit; a VSWR-cum-power indicator circuit; and a carrier operated relay circuit.

The booster is based on two 2SC2290 RF power transistors arranged in a standard push-pull design and operating in class B mode.

Starting at the input, the RF signal from the transceiver is fed via relay contacts RL2a to the 2:1 attenuator network and thence to transformer T1. This scales the input impedance down by 16:1, from 50 ohms to around three ohms, to drive the power transistors (Q101 and Q102).

Base bias for the power transistors is provided by Q103 which is configured as a diode. Because it is thermally coupled to the heatsink, this arrangement also prevents thermal runaway of the power devices. The hotter the heatsink becomes due to dissipation in Q101 and Q102, the hotter Q103 becomes.

And the hotter Q103 becomes, the lower the voltage across it and therefore the lower the bias on the power transistors. Q101 and Q102 are thus automatically throttled back as the heatsink temperature rises.

Resistor R7 limits the bias current to about 100mA per device, while capacitors C107-C113 provide supply decoupling. Inductor L101 is designed to filter out RF in the bias supply to Q101 and Q102.

The collector outputs of the power transistors drive output transformer T2. This transformer steps up the output voltage and, in turn, drives the following low-pass filter stage. Trimmer capacitor TC101 and parallel capacitor C106 tune the output transformer primary to give maximum power transfer and to guard against output stage oscillation.

Negative feedback for the booster is derived from a single winding on the output transformer secondary and is applied to the bases of Q101 and Q102 via series RC networks. This helps maintain a low VSWR across the input transformer and also helps compensate for gain variations over the 1.8-30MHz range.

The low-pass filter stage consists of six independent sections arranged in standard Chebyshev configuration (L2-L13 and C14 to C41). The −3dB cutoff frequencies are listed in Table 1. Double-pole switch S3 selects the required filter and couples the RF energy to the following VSWR-cum-power indicator stage.

VSWR/power indicator

The VSWR/power meter is fairly conventional. It employs a current transformer consisting of a centre-tapped secondary wound on a toroid, with the primary being a heavy gauge conductor through the middle. Diodes D10 and D11 rectify the voltage developed across L1 due to the forward power. The resultant DC signal is then applied to the meter movement via calibration trimpot VR1.

Trimmer capacitor TC1 is used to peak the circuit for a maximum reading on the meter.

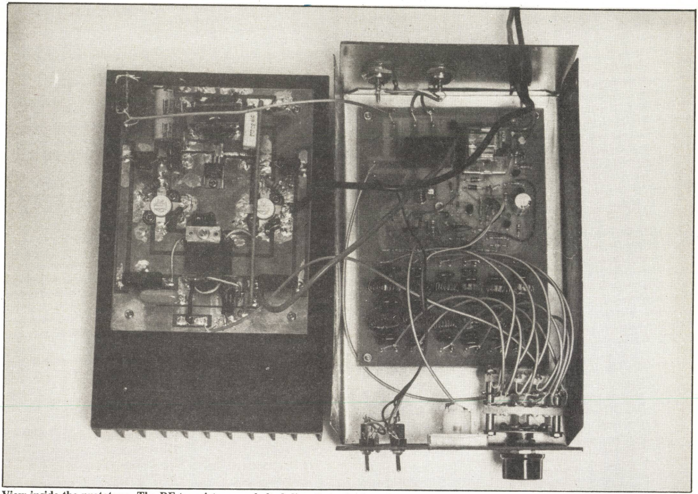
Similarly, D12 and D13 rectify the voltage developed across L1 due to the reflected power. This signal is then applied via VR2 and R17 to the gate of SCR1 in the carrier operated relay circuit. More on this later.

TABLE 1

Band	-3dB Fc	Suitable For:
160 metres	2.5MHz	1.8 - 1.86MHz
80 metres	5MHz	3.5 - 3.8MHz
40 metres	10MHz	7 - 7.3MHz
20-30 metres	17MHz	10.1 - 14.35MHz
14-16 metres	26MHz	18 - 21.45MHz
10 metres	31MHz	28 - 29.7MHz

Table 1: 3dB cutoff frequencies for the filter switch settings.

HF Linear Amplifier



View inside the prototype. The RF transistors are bolted directly to the heatsink.

Carrier operated relay

Q1, Q3 and Q4 form the relay switching circuit. This switches the amplifier into circuit on transmit, and switches the amplifier out of circuit during receive. Ignore Q2 and the two SCRs for the time being — they're in the protection business.

Here's how the circuit works: During receive, Q1 and Q3 are off. Thus, relay driver transistor Q4 is also off and the transceiver is connected directly to the output socket via relay contacts RL2a and RL2b.

When the transmit button is pressed, part of the signal passes via C1 to a diode pump consisting of D1 and D2. This charges C2 and provides base bias for Q1 which turns on. Thus, Q3 and relay driver Q4 also turn on and so power is applied to the amplifier circuit and to the on-air LED (D15) via relay contacts RL1a.

At the same time, power is also applied to RL2 which turns on and switches the amplifier into circuit.

When the transmit button is released, the relays remain on for a short time until C3 charges sufficiently to turn Q3 (and thus Q4) off. Switch S2 considerably extends the relay dropout time for SSB and CW by switching out R3. This is necessary to prevent relay chatter since there is no carrier in SSB mode and only an intermittent carrier in CW mode.

Protection

The remaining components shut the circuit down if there is excessive VSWR, RF overdrive or excessive supply voltage. Let's look at the VSWR protection circuit first. This consists of Q2 and SCR1.

As described previously, the output from the reverse side of the VSWR circuit is connected via R17 to the gate of SCR1. Normally, both Q2 and SCR1 are off but if the VSWR signal becomes excessive, the SCR turns on and provides base current for Q2. This turns Q2 on and Q3, Q4 and the relays off, thereby switching the booster out of circuit.

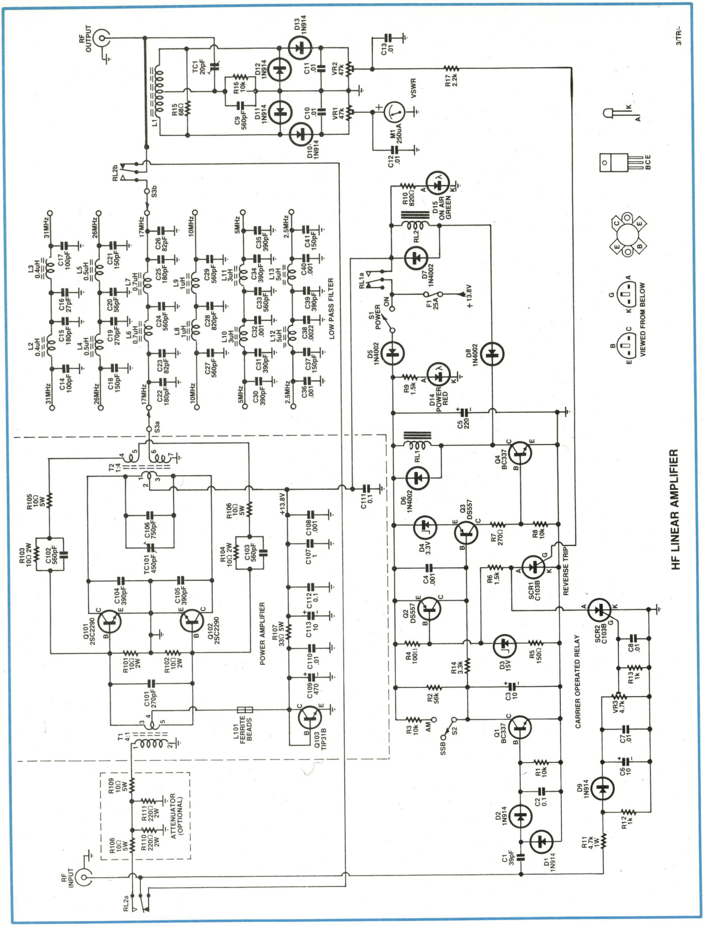
Q2 and SCR2 work in exactly the same way to protect the booster from RF overdrive. In this case, RF energy from the transceiver is first applied to a voltage divider consisting of R11 and R12. D9 then rectifies the divider output and charges C6. The higher the RF drive, the higher the voltage across C6.

This voltage is sampled by VR3 and applied to the gate of SCR2. If the RF drives becomes excessive, the voltage across C6 rises and the SCR is triggered into conduction. As before, this turns Q2 on and the relays off.

Trimpot VR3 sets the drive level at which the circuit trips. It can be set to any desired level up to a maximum of 15W. Note that the SCR1 and SCR2 protection circuits can only be reset by turning the power switch off for several seconds and then on again.

Zener diode D3 provides protection against excessive supply voltage. Because the supply voltage is usually around

Fig.3: the circuit uses two RF transistors, Q101 and Q102, operating a standard class B push-pull mode.



HF LINEAR AMPLIFIER

PARTS LIST
Booster PCB

Semiconductors

Q101, Q102 — 2SC2290 RF power transistors
Q103 — TIP31B NPN power transistor

Capacitors

C101 — 270pF dipped mica DM-15 series, 500V
C102, C103 — 560pF dipped mica DM-15 series, 500V
C104, C105 — 390pF dipped mica DM-15 series, 500V
C106 — 750pF
C107 — 1uF metallised polyester
C108 — .001uF dipped mica DM-16 series, 500V
C109 — 470uF 25VW axial mounting electrolytic
C110 — .01uF dipped mica DM-15 series, 500V
C111, C112 — 0.1uF ceramic
C113 — 10uF 25VW PC-mounting electrolytic
TC101 — 450pF trimmer, GMC31000 Sprague

Resistors (5%, non-inductive)

R101, R102, R103, R104 — 10 ohms 2W
R105, R106, R108, R109 — 10 ohms 5W
R107 — 33 ohms 5W
R110, R111 — 220 ohms 2W

Miscellaneous

2 ferrite beads
6 F16 ferrite cores
1 PCB, ZA-1500
1 5-lug tag strip
1 600mm x 2mm insulated hookup wire
1 300mm x 1.6mm tinned copper wire
4 PCB transformer end pieces
4 3mm spacers
4 3mm x 12mm bolts
5 3mm x 7mm bolts
1 150mm x 2mm spaghetti insulation
1 TOP-66 mica insulating washer
1 3mm bush insulator
1 10 x 10cm copper shim
1 heatsink compound

Carrier operated relay PCB

Semiconductor

Q1, Q4 — BC337 NPN transistor
Q2, Q3 — DS557 PNP transistor
D1, D2, D9, D10, D11, D12, D13 — 1N914 diode
D3 — 15V zener diode
D4 — 3.3V zener diode
D5, D6, D7, D8 — 1N4002 diode
D14 — large red LED plus mounting bezel
D15 — large green LED plus mounting bezel
SCR1, SCR2 — C103B SCR

Capacitors

C1 — 39pF ceramic
C2 — 0.1uF ceramic
C3 — 10uF 25VW tantalum
C4 — .001uF ceramic
C5 — 220uF 25VW PC-mounting electrolytic
C6 — 10uF 25VW tantalum
C7, C8, C10, C11, C12, C13 — .01uF ceramic
C9 — 560pF ceramic

Dipped mica capacitors, DM-15 series, 5%, 500V

C14, C17 — 100pF
C15, C22, C25 — 180pF
C16 — 27pF
C18, C21, C37, C41 — 150pF
C19 — 270pF
C20 — 56pF
C23, C26 — 82pF
C24, C27, C29, C33 — 560pF
C28 — 820pF
C30, C31, C34, C35, C39 — 390pF
C32, C36, C40 — .001uF (1000pF)
C38 — .0022uF (2200pF)

Resistors (0.25W, 5% unless stated)

R1, R3, R8, R16 — 10k
R2 — 56k
R4 — 100 ohms
R5 — 150 ohms
R6, R9 — 1.5k
R7 — 270 ohms
R10 — 820 ohms
R11 — 4.7k 1W
R12 — 1k 1W
R13 — 1k
R14 — 3.3k
R15 — 68 ohms
R17 — 2.2k
VR1, VR2 — 47k large vertical trimpot
VR3 — 4.7k large vertical trimpot

Inductors (see Table 2)

L1 — 10 turns bifilar, 0.6mm enamelled copper wire on Amidon yellow core
L2, L3 — 0.4uH
L4, L5 — 0.5uH
L6, L7 — 0.7uH
L8, L9 — 1uH
L10, L11 — 3uH
L12, L13 — 5uH

Miscellaneous

1 PCB, code ZA-1501
S1, S2 — SPDT toggle switch
S3 — 2 pole, 6 way rotary switch
RL1, RL2 — DPDT relays
M1 — 250uA FSD meter
1 2.3-metre length RG-178 coax
1 30A fuse and fuseholder
1 1-metre length red/black power cable
1 cable clamp grommet
1 knob
4 6mm spacers
4 rubber feet
4 3mm bolts, 13-16mm long
4 3mm nuts and star washers
46 PCB pins
1 275mm x 6-way ribbon cable
2 SO239 sockets
4 Philips 3mm x 8mm self-tapping screws
4 3.5mm x 9mm self-tapping screws
6 3mm x 12mm bolts
1 finned heatsink, 220 x 136 x 38mm
1 case with front and rear panels

+13.8V, D3 is normally non-conducting. But if the supply rises above about 17V, D3 conducts and provides base current for Q2. Once again, Q2 turns on and the relays switch the booster out of circuit.

Finally, diodes D5 and D8 provide protection against reverse connection of the battery, while D6 and D7 protect Q4 from voltage spikes when the relays turn off.

Next month, we shall give the full construction and alignment details. In the meantime, you can order your kit from Dick Smith Electronics (see box).

Where to buy the kit

This project was developed in the Research and Development Department at Dick Smith Electronics Pty Ltd. It is available as a kit of parts only and can be purchased by mail order or from your nearest Dick Smith Electronics Store.

The kit comes complete and includes fibreglass PCBs, predrilled metalwork, and prepunched front and rear panels with screened lettering.

Mail orders should be addressed to: Dick Smith Electronics Pty Ltd, PO Box 321, North Ryde 2113. Phone (02) 888 2105.

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As described in May '84 EA

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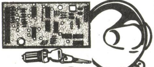
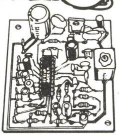


Stereo Decoder...



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Powerful 100W SSB rig for all HF marine frequencies... handles emergency, club and chatter over 2-30MHz range. Plug-in frequency cards for simple single knob frequency selection. DOC approved. Excellent value for a fine unit! **$1795**

ONLY THE BEST

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Forget Antenna Tuning Hassles!

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Cat D-1412

Noise Blanking Mute Cord

Fitted in your transceiver to prevent ignition noise and other forms of pulse type interference. D-1414 **$139**

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Just the thing for those smaller craft going off shore. Complete with base and lead.

D-1418 **$129**

Economy Marine

10 Channel, 27MHz transceiver that won't sink the budget! Yet provides max. legal output on all channels, auto noise limiter and ceramic filter. LED freq. display and squelch. Doubles as PA amp with optional power horn. DOC Approval: 2440040 **$139**

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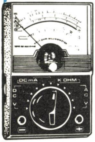

Mini Multimeter. Budget price, pocket-size 11 range 2000 ohm/volt tester that goes anywhere. Great value! Cat Q-1010

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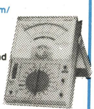

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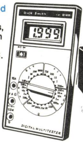

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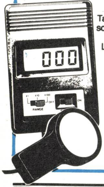

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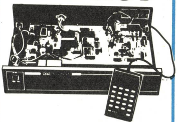

TV Stereo Decoder. Transforms old mono set into a modern stereo entertainer - why buy a new TV! Features built-in VHF/UHF tuner. Line outputs and 1 watt stereo audio amp. Cat K-6325

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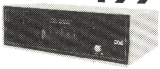

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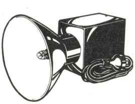

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Economy 3.5 wide-angled LCD meter (in 10 ranges) with RF shielding, overload protection. Handles 250V or 350V indefinitely, over 350V or 500V DC for up to 30 seconds. Cat Q-1520

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Affordable 4.5 digit bench top that's versatile enough to take with you! Extremely accurate with high resolution. Cat Q-1550

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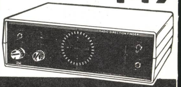

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We're deliberately not trying to stock the whole range in Australia or New Zealand: look at the Heathkit catalogue and you'll see it's immense! It's simply not possible to hold this amount of stock in a small market such as Australia/New Zealand.

This doesn't mean, however, you cannot get other Heatkits: we will order **any kit** in the Heathkit range against a firm deposit, with the exception of computer kits or learning/training aids.

You should keep in mind that some kits are specifically American in nature — such as NTSC colour TV's. Of course, if you specifically **want** an NTSC colour TV, we can order one for you.

Because of the rapidly fluctuating dollar, we cannot print firm prices on these kits: however, one phone call to our Heathkit Information Line will get you the current price.

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Exactly match your antenna system to your transceiver: minimise losses, maximise efficiency. The Heathkit Antenna Tuner features very high power handling (1kW CW) over the full HF bands, with roller inductor, dual wattmeters and built-in 4:1 balun.

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Cat G-2010 **$299**

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Work with FM? You need this one. Deluxe deviation meter accurately and quickly checks deviation from 2 to 75kHz, over the range of 25 to 1000MHz. No more reports of "over deviation, om!" — you can even leave this in line for continuous checks.

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Cat G-4005 **$149**

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Check out RF, IF even audio circuitry quickly and easily. Trace through until you find the fault. A must for the work bench.

Cat G-4015 **$149**

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QRP transceiver just right for the novice or avid CW enthusiast. CW coverage on 80, 40, 20 and 15 metres with RF output up to 4 watts. Ideal for portable/battery operation too.

Cat G-3020 **$499**

Accessory Band Pack for QRP transceiver

Allows operation on WARC bands — 30, 17 and 12 metres plus 10 metres.

Cat G-3021 **$75**

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"The most accurate clock" you'll ever own. Tunes into WWV or WWVH for time signals accurate to 10mS; displays in digital form down to 0.1 second. Can display any of the world's 24 standard time zones. Outdoor antenna recommended.

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1kW dummy load in a 4 litre can. Less than 1.5:1 VSWR up to 450MHz; ideal for on-air testing or alignment without any RF getting out. Needs 4 litres transformer oil (not supplied).

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Get better weather information than the weather bureau gives! Famous world-wide, the Heathkit computerised weather station gives wind speed and direction, wind chill factor, temperature, barometric pressure (and whether its rising or falling)... everything! If your business is knowing the weather, the Heathkit weather computer is for you! Everything supplied — including sensors and cable.

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The robot of the future is here today. It's Hero Jr — from Heathkit, of course. More than just a robot, Hero Jr will become a real member of your family. He (she?) is pre-programmed: Hero Jr will wake you up (even listen to make sure you're awake!), remember dates and anniversaries, walk, talk, protect you and your home (even activate your security system for you!) and much, much more. You can re-program Hero Jr via its own keypad or with your home computer (needs RS232C link). Of course, Hero Jr is battery operated and comes with an AC recharger.

Cat G-1005 **$1395**

(Also available built up: Cat G-1000 @ $1995)

Accessories:

Infra Red Motion Detector (for security applications)	Cat G-1010	$399
RS232 interface (re-program hero from your own computer)	Cat G-1030	$179
Cartridge Adaptor (for plug-in command cartridges)	Cat G-1050	$179
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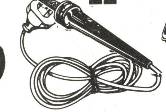

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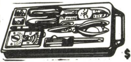

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Low cost dummy load

Put six light bulbs in a screened box, fit a six-way switch and what have you got? Answer: a low-cost dummy load that's just the shot for service work.

by JIM LAWLER (MTETIA)

When servicing TV sets we often require some means of loading the power supply without risking damage to expensive transistors or other components in the line output stage.

Then again, although most TV power supplies incorporate current limiting, it is often an advantage to have some kind of backstop current limiter in series with the output transistor during line output stage troubleshooting.

There is one common, cheap, easy-to-use component that is ideal for both of these jobs, and in other places as well. This is the ubiquitous light bulb or incandescant lamp.

I usually keep a 100 watt lamp in the workshop for this kind of testing, but recently, while adjusting the output of the EA 300 Watt Inverter, I had need for both low and high value loads. I "pinched" enough 100 watt lamps from the lounge and dining rooms to solve the high value problem but low wattage lamps are not so common.

I solved my immediate problem by borrowing a 45 watt lamp from the little room but later, while sitting in the dark, I decided that I had to build up a proper dummy load with a wide range of wattages instantly available.

To use a lamp as a service aid in TV work, I had used a bayonet socket from an old lamp fitting with a short length of flex and two alligator clips. I sometimes added an old double adapter if it was necessary to increase the load beyond that offered by one lamp.

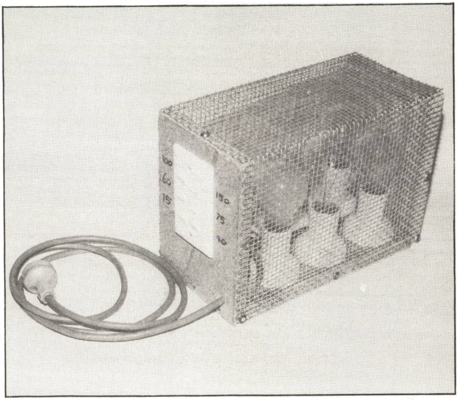
This system worked well enough, although an awful lot of lamps met a premature end when bashed against the bench, or squashed under TVs. My new setup would have to be rugged enough to protect the lamps from workshop perils.

The final design suggested itself one day when I was picking up some stores from one of my suppliers. On his wall was a display of HPM electrical fittings, including a switch plate holding six rocker switches. This plus six batten holders, a few scraps of particle board, some short lengths of power cord and a metal screen allowed me to put together the "ultimate" dummy load.

My contraption is fitted with six lamps, one each of 15, 45, 60, 75, 100, and 150 watts. These are all readily available and quite cheap. Used singly or in combination, they can offer a wide variety of loads up to 445 watts at 240 volts.

The photograph shows how I arranged these parts, but any arrangement would be suitable, provided the lamps are protected from physical damage and are well ventilated. This unit has been fitted with a three pin plug for testing the 300 watt inverter mentioned earlier but it could be fitted with alligator clips, or adapters made up to fit any type of plug or socket that might be required.

When using lamps like this as dummy loads, it is wise to remember that they will dissipate their rated power only when fed from 240 volts. Their consumption is all over the place at lower voltages because of their different temperature coefficients.



The light bulbs and switches are all wired in parallel.

An infrared remote control preamplifier

This second and final article on the IR Remote Control Preamplifier describes the construction and setting up procedure. The Dick Smith kit will include prepunched metalwork, moulded remote control case and all hardware down to the last screw and nut.

by JOHN CLARKE

Construction of the IR Remote Control Preamplifier involves assembling five printed circuit boards (PCBs), plus a small amount of wiring and mechanical assembly. Overall it should take only a few nights work to have the system operational.

IR Transmitter

Two PCBs for the remote transmitter are designed to insert into the moulded plastic case. The keypad PCB (coded ZA-1599) is secured with screws to the case lid which retains the keypad switches in position. The ZA-1598 PCB circuit clips into the base of the case. It is shaped like a chunky "T" in order that it can use the integral plastic clips to secure the PCB in position.

Beginning with the keypad PCB, there are ten wire links required and these should be mounted on the top of the PCB as shown on the overlay diagram. After soldering, crop the wires short on the copper side so that they will not foul the plastic membrane switch when assembled.

A 9cm length of 12-way rainbow cable connects to the bus at the edge of the PCB. This is labelled from R1 to R8. Separate each wire from the end of the cable for about 2mm and strip the insulation about 1mm back from the ends. Twist the strands of each wire together and insert the wires into the holes from the top side of the PCB. They can now be soldered.

Assembly of the ZA-1598 circuit PCB requires that the high profile components (L1 and C1 to C3) be placed side-on so that the PCB will fit within the case. Take care with the polarised components such as the IC, transistors and C3. The transistors should be inserted and pushed down close to the PCB. Note that there is provision for a second 470μF/16VW capacitor below C3. This should be used to obtain better transmitter range if a standard 9V battery is used rather than an alkaline type.

The IR LEDs are mounted proud of the PCB so that when the PCB is clipped in position, the LEDs rest on the integral plastic supports within the case. To do this, bend the anode (longer) lead at 90 degrees 10mm from the LED base and the cathode (k) lead 7mm from the LED base. Insert each LED so that it is raised above the PCB by 8mm.

The rainbow cable also connects to the R1 to R8 bus on this PCB. Make sure that this cable is oriented so that R1 on the keypad PCB also connects to R1 on the main PCB. Finally, the battery wires connect to the PCB with the red wire going to the plus (+) terminal.

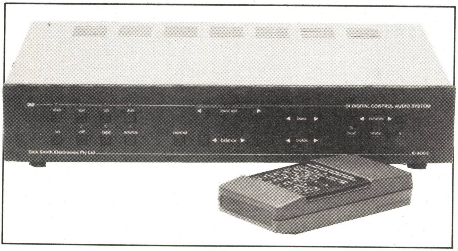
Clip the main PCB onto the base of the case and insert the battery clip through into the battery compartment.

The keypad label can be affixed to the front of the case lid and the rectangular holes for the switches trimmed out with a sharp knife. Place the switch tops into the holes and place the membrane switch matrix inside the lid. The keypad PCB screws to the lid and is oriented so that the rainbow cable exits from the window end of the lid.

Finally, place the red plastic window into the front of the case and clip the whole case assembly together. It is secured with a screw near the battery compartment.

Power Supply PCB

Work can now begin on the power supply PCB. This is coded ZA-1597.



Begin with the low profile components such as the resistors, diodes and transistors. Be careful with the orientation of the diodes and transistors. Insert the capacitors, making sure that the electrolytic capacitors are oriented so that the plus sign on the capacitor body matches the PCB plus sign position.

The heatsink is secured to the PCB using screws from the underside of the PCB. These tap into the heatsink extrusion. After smearing heatsink compound on the regulator tab face (IC1), insert it into the PCB and screw it to the heatsink. Now solder the regulator to the PCB.

Finally the relays and PCB terminal block can be soldered in place. The completed board can then be set to one side so that work can progress on other boards.

Analog and Logic PCB

The analog and logic board, coded ZA-1597, is the largest board of the preamplifier system. Assembly should begin by installing all the links, resistors, diodes and ICs. Take care with the IC orientation and note that IC1 is oriented differently to the remaining ICs.

L1 and L102 are ferrite beads with one turn of enamelled copper wire through the centre. Strip back the insulation at the ends before soldering. Now install the capacitors and transistors.

Finally, the trimpots and PCB-mount RCA socket assemblies (two) can be installed making sure that the RCA sockets are stood at right angles to the PCB.

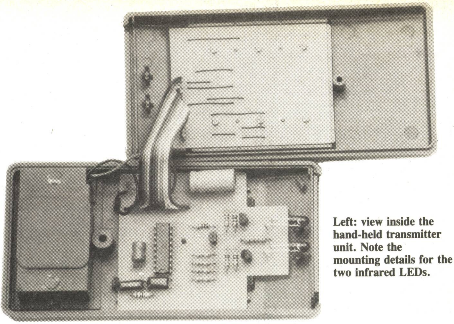
A small amount of wiring is also necessary on this PCB. First, there is a 6-way ribbon cable 145mm long connecting between the −ve, sa, sb, +ve, st and sl terminals. Second, there is a stereo pair of shielded cable connecting from the end-most RCA sockets of CN2 to R27 and R227. The shield of the cable is connected at the socket end only.

Control board

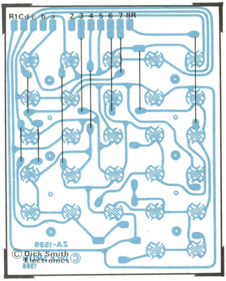
The final PCB for assembly is the display or control PCB, coded ZA-1596. This mounts vertically behind the front panel and carries all the pushbutton switches. Begin assembly with the links, resistors and ICs. Note that IC1 is bent over so that it lies flat onto the PCB. Its orientation is such that the chamfered edge faces the top edge of the PCB (hence the dotted line on the package outline of the overlay).

The capacitors and inductors L2 and L1 are all inserted so that they lie flat on the PCB. Again, be careful with the orientation of the electrolytic capacitors. The two transistors Q1 and Q2 should be mounted as close as possible to the PCB. Next install the trimpot VR1.

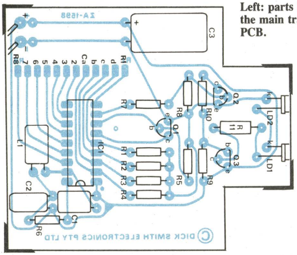
The PCB mounting push button



Left: view inside the hand-held transmitter unit. Note the mounting details for the two infrared LEDs.

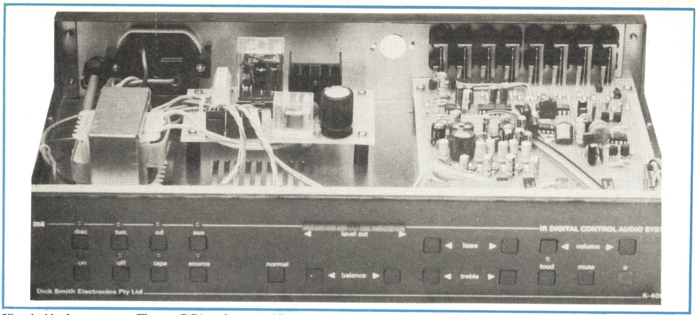


Parts layout for the keypad PCB. Install the 10 wire links first.



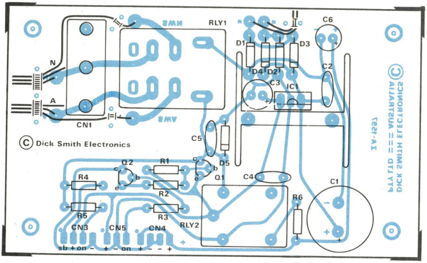
Left: parts layout for the main transmitter PCB.

The transmitter circuitry is housed in an attractive moulded plastic case.



View inside the prototype. The two RCA socket assemblies are soldered directly to the analog and logic PCB.

Remote control preamplifier



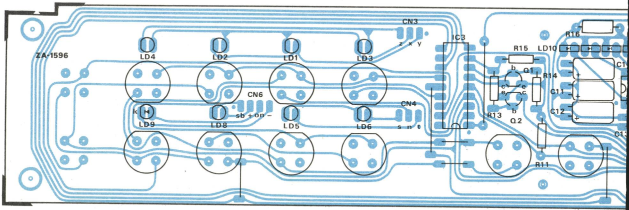
Here is the parts layout for the power supply PCB. Take care with the mains wiring.

switches are mounted hard against the PCB with the "flat" side oriented as shown on the overaly. Note that the left-most locations for the switches are not used.

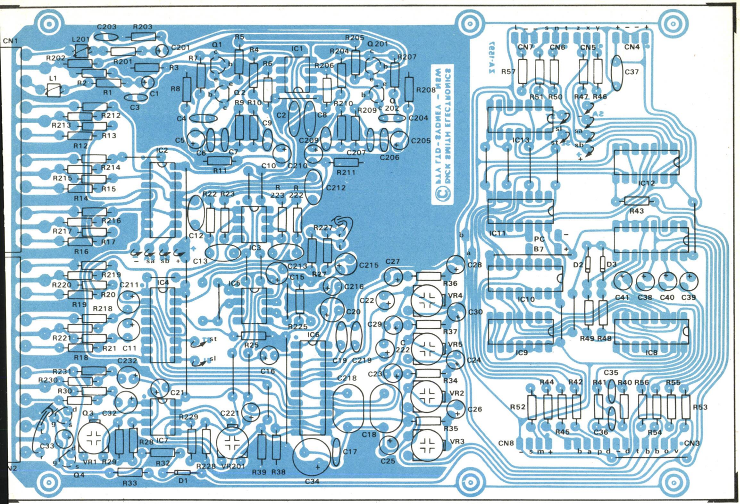
Once the switches have been installed, the LEDs can be placed in position. Note that the long lead of the LED is the anode and the short lead the cathode (k). They are installed so that the top of the LED shoulder is at the same height as the shoulder on the switches. Solder only one lead at this time to allow adjustment in the front panel, as necessary.

Note also that LD9 is red and LD8 is green while the remainder from LD1 to LD6 are orange. The level display LEDs from LD10 to LD18 are all green except for LD14 (centre LED) which is red.

The photodiode PH1 is mounted proud of the PCB to the same level as the switch shoulders. Note that the



The control board carries the switches and LED displays and is mounted on standoffs behind the front panel.



Most of the work involves assembly of the analog and logic board. See text for on-board wiring details.

chamfered edge is located toward the top edge of the PCB.

This completes the PCB construction. The remaining work consists of wiring and assembly.

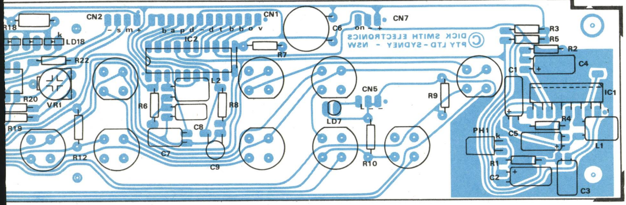
Assembly and Wiring

Bolt the mains socket to the rear and the transformer to the base using machine screws and nuts. The earth lug is bolted to the baseplate as shown on the wiring diagram. It uses two nuts with spring washers.

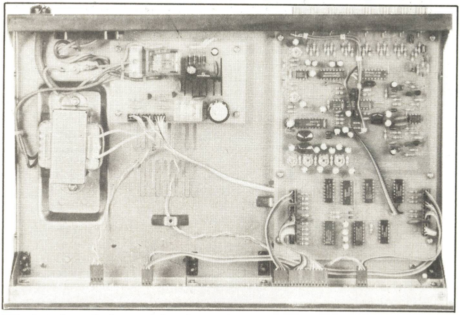
Follow the wiring diagram for the mains and transformer connections. Secure the mains cord using the cord clamp grommet and terminate the mains wiring directly onto the power supply PCB. They are soldered quickly to avoid melting the insulation. Be certain that the earth wires (green/yellow) are soldered to the earth lug and connected to the earth on the mains socket.

Holes are provided in the PCB to accommodate tying the wires down with cable ties.

Temporarily support the power supply PCB using the 4 × 15mm standoffs in readiness to test the power supply PCB. Recheck the wiring and switch on the



Remote control preamplifier



This photo shows the layout of the sub-assemblies inside the chassis.

mains power. Check the voltage at the output of the regulator using a multimeter. It should be about 15V. The relay operation can be checked by connecting a jumper lead between the (–) and (on) terminals of CN5. The 15V supply should now appear at the (+) output of CN4.

Now the rainbow cable for the interboard wiring can be prepared.

Temporarily locate the main analog/digital PCB on 6 × 15mm standoffs and position the front display PCB on the supplied standoffs. This will allow the lengths for each cable to be determined. The wiring diagram shows the interconnections and the number of wires required for each cable. Note that wiring from the CN6 and CN5 terminals of the main analog/digital PCB goes to the CN4 and CN3 terminals of the control board respectively. The CN7 terminals of the main PCB go to the CN5 terminals of the control board.

Cut each cable to length, strip back the insulation and twist the strands of each wire.

You will need to gain access to the base of the PCBs before attempting to solder the wires in place. For the power supply and main PCB, the wires are inserted into the PCB from the top of the PCB and soldered on the copper side. The control board wiring is done from the copper side of the PCB. For these the wire is inserted into the holes leaving sufficient stripped wire to allow soldering. Make sure that the polarity is correct for each cable.

Reinstall the PCBs on the standoffs and screw the RCA sockets on the main analog/digital PCB to the rear panel using 4 × 8mm self tapping screws. Now the front panel can be secured to the front of the case with spacers. Carefully place this in position, making sure that the switches and LEDs protrude through the holes. Check operation of the switches for binding and solder the LEDs in position. If necessary, the front panel may require slight repositioning to free the switch operation. A square red bezel inserts into the infrared detector hole position and is glued in place.

Setting-up

Initially, set all the preset pots to centre position. Now connect up the mains supply. The green "off" indicator should light. Press the "on" switch and the red LED should light as well as the Tuner and Source selection LEDs. By pressing the other selections, the indicator LEDs above them should light.

Pressing the balance, bass, treble and volume controls should cause the bar graph display to display in the dot mode. The level should progress up or down the display for the up or down pushbutton switches of each function.

If any of these functions do not operate, check the PCBs for faults such as incorrect component placement and wiring errors. Also check power supplies and trace through the circuit operation to locate the fault. Most faults are not due to faulty ICs since they are very rugged and reliable unless incorrectly connected to the power supply. Look for other problems before suspecting an IC.

Test the remote control unit to check that its controls all operate correctly.

Calibration

To calibrate the level set display, it will be necessary to have access to the VR1 trim pot on the control board by removing the front panel. Press the normal switch and adjust VR1 until the display has three LEDs lit. Now press a balance control switch to check that the red centre LED initially lights before the display moves off centre. Press the normal switch again and press the opposite balance switch. The centre LED should again light before the display moves off centre. If not readjust VR1.

Setting up the analog control presets from VR2 to VR5 requires a high impedance meter such as a digital multimeter. Press the volume up switch until maximum volume is obtained. This is when all the LEDs are extinguished while the switch is pressed. Now measure the voltage on pin 12 of IC6 and adjust VR2 for a reading of 5V DC on the multimeter.

Similarly, the balance, treble and bass controls should be set to a maximum on the level set display. The voltage at pin 9 is set with VR3, pin 4 is set with VR4 and pin 14 is set with VR5 respectively. These should all be set to 5V DC.

Finally, replace the front panel and secure the top lid to the case.

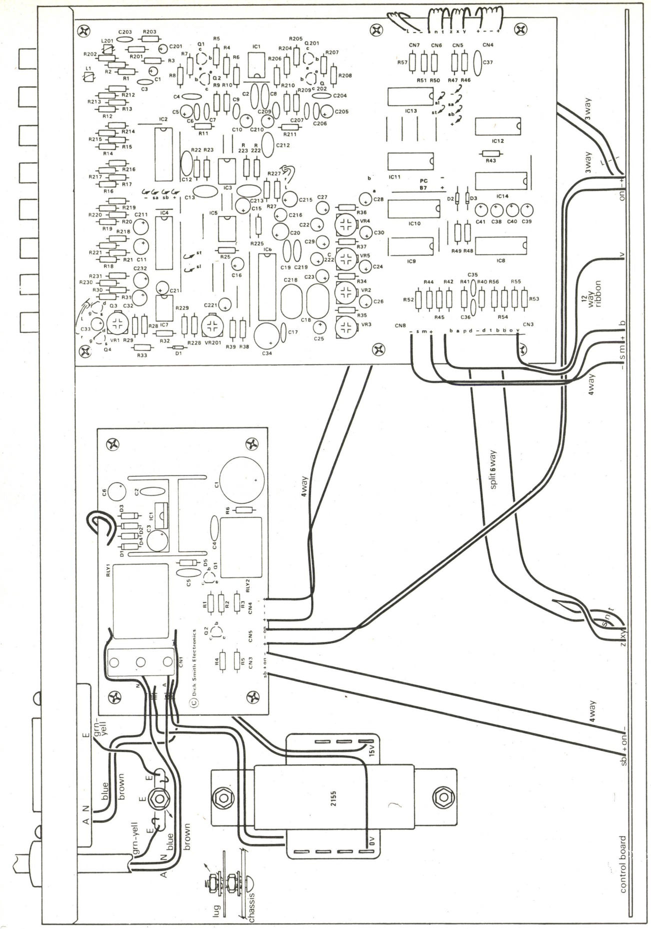
Testing

The unit is now ready to be tested with your sound system. Connect a

continued on page 126

Where to buy the parts

This infrared remote control preamplifier has been developed and produced by the Research and Development Dept. at Dick Smith Electronics Pty Ltd. It is available as a kit of parts only and can be purchased by mail order or from your nearest Dick Smith Electronics store. The cost is $279 plus postage and packing charges where applicable.



Follow this diagram carefully when wiring up the PCB sub-assemblies. Caution: the power supply board carries mains voltages.

Don't let the boat sink. Build this

Solar-powered bilge pump

Keep the boat afloat when you're not around with this automatic bilge pump. It's easy to make and, best of all, it's powered by sunlight.

by COLIN DAWSON

There were many innovative and useful circuit ideas submitted to our recent solar panel contest. One that struck us as being simple, useful and making good use of solar energy was an automatic bilge pump, suggested by Peter Holloway of Perth. We have adopted his idea and designed a low-cost circuit suitable for construction on a printed circuit board (PCB).

The concept of "free" energy from the Sun is an inherently appealing one. Although it is not quite fair to refer to solar panels as free energy, since they have to be bought in the first place, they can be an attractive proposition when there is no easy access to mains power.

In this project, a 12V solar panel is used to top up a battery so that it can power an automatic bilge pump. Without the panel, the battery could quickly go flat, particularly if the boat was leaky and the bilge pump cut in quite frequently. It's obvious what would happen if the battery did go flat — the bilge pump would stop operating and the boat would eventually sink.

Add a solar panel though, and the scenario changes completely. Even the quite modest power of 7W available from a cheap 12V panel is enough to cover a couple of hours pumping per day. The battery is still needed but, except where the boat is inundated, it will not discharge in the long term.

Solar panels with a nominal output of 12V are available from several component retailers. The price for a 700mA unit at the time of writing seems to average about $90 although Amtex has a higher power version which is more expensive. Although rated at a nominal 12V, most of them have an open circuit output of up to 18V, depending on the light intensity.

In practice, the battery itself will not allow the solar panel output to rise above about 14.5V.

Naturally, an automatic bilge pump has to have some means of sensing the water level. We envisage that some sort of float and microswitch assembly will do the job in most cases. These level sensors are readily available from boating suppliers.

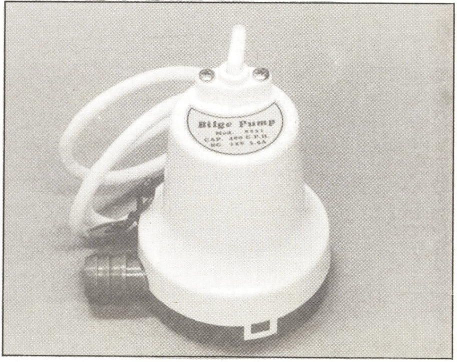
However, the earth seeking input of our control circuit could easily be adapted to other sensors. It could, for example, be used with a moisture sensing element set up to detect either salt or fresh water, depending on your circumstances (more about this later).

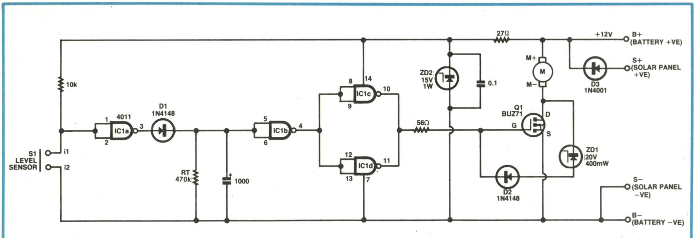
Most boating suppliers will also be able to sell you a bilge pump. Our sample bilge pump from Amtex was rated at 12V DC 3.5A and is capable of pumping around 1800 litres (400 gallons) per hour.

Time delay

One important feature of the circuit is an inbuilt time delay. This holds the pump on for about 30 seconds after the float microswitch opens and so stops the pump from continually cycling on and off as the boat moves on a swell. If the microswitch then closes again inside the timing interval as the boat moves about, the circuit simply retriggers for another 30s.

This low-cost bilge pump is capable of pumping 1800 litres per hour.





BILGE PUMP

Fig.1: IC1 performs level sensing while MOS transistor Q1 switches the pump motor in and out of circuit.

Only when there has been no new trigger for 30s will the circuit switch off.

Note that, with particularly choppy sea, the pump inlet may be uncovered briefly. The same may happen for small boats which can be quickly emptied by the bilge pump. This is nothing to worry about however, as the pump motor is rated for continuous operation with or without water transfer.

How it works

Since every milliwatt counts with a low capacity source such as a solar panel, relay control of the motor was considered unsuitable due to the power wasted in the coil. Instead, we elected to use a MOS transistor to control the motor. This is a voltage controlled device and has negligible gate current.

It is also smaller and more compact than a relay and can be driven directly from a CMOS control IC. So use of a MOS transistor gives us a simpler, more compact circuit.

Refer now to the circuit diagram (Fig.1). It's really very simple. MOS transistor Q1 (BUZ71) is connected in series with the pump motor and functions purely as a switch. When the transistor turns on, the pump turns on and vice versa.

Q1 in turn is controlled by IC1 which is a 4011 CMOS quad NAND gate IC. This is about the cheapest CMOS IC going — around 60 cents seems to be average.

The water level sensor is connected to pins 1 and 2 of IC1a, which acts as a switch/detector. Its input is normally held high by the 10k resistor but is pulled low by the water level sensor. When this happens, its output (pin 3) switches from low to high.

When IC1a's output is high, D1 is forward biased and the 1000uF capacitor quickly charges. In fact, the capacitor will be held in the fully charged state for as long as the high water condition exists.

During this time, pin 4 of IC1b is held low and thus the outputs of parallel buffer/inverter stages IC1c and IC1d are high. This high is coupled to the gate of Q1 (BUZ71) via a 56 ohm resistor.

When its gate is held high, Q1 is on and thus the pump motor is also on.

Normally, you would expect that a reverse diode would be connected across Q1 to protect the transistor against voltage spikes generated by the back EMF of the motor. This would certainly be the case if Q1 were a bipolar transistor, but the SIPMOS transistor has the diode connected internally. However, we do need to limit the drain to gate voltage and this job is performed by diode D2 and zener diode ZD1.

When the water level subsequently drops below the critical level, the microswitch (S1) opens and the pin 3 of IC1a switches low. D1 is now reverse biased and so the 1000uF capacitor begins discharging through Rt.

After about 30 seconds, pin 4 of IC1b switches high again and the outputs of IC1c and IC1d switch low. This turns off Q1 and the motor.

Note that the 30s time delay can be easily altered by adjusting the value of Rt. Do not make the time delay too long though, otherwise the pump will continue to run after the bilge has been pumped dry.

Power for the circuit is derived from a 12V auxiliary battery and this is applied direct to the motor. A 27 ohm resistor and 0.1uF capacitor decouple the supply to IC1, while zener diode ZD2 limits the supply to 15V. While this primarily provides protection against inductive kickback from the motor, it also serves the secondary function of preventing the solar panel voltage from exceeding 15V. This could otherwise occur if the battery was disconnected.

Finally, the solar panel is connected in parallel with the battery via diode D3. This diode prevents the solar panel from discharging when the output from the solar panel falls below the battery voltage.

Construction

The circuit is built on a small PCB coded 86pc11 and measuring 63 x 45mm.

PARTS LIST

1 PCB, code 86pc11, 63 x 44mm
1 8-way PC-mounting terminal block
1 bilge pump (see text)
1 solar panel (12V nominal)
1 water level detector (see text)

Semiconductors

1 BUZ71 SIPMOS N-channel transistor
2 1N4148 diode
1 1N4001 diodes
1 15V 1W zener diode
1 20V 400mW diode
1 4011 CMOS quad NAND gate

Capacitors

1 1000uF PC-mounting electrolytic
1 0.1uF metallised polyester

Resistors (0.25W, 5%)

1 x 470k, 1 x 10k, 1 x 56 ohm, 1 x 27 ohm

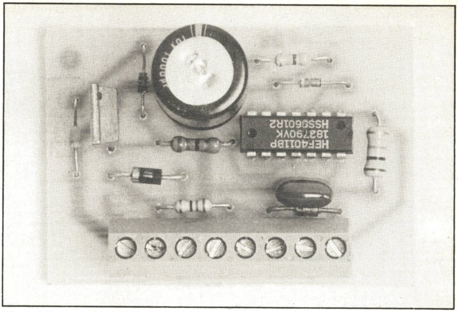
Where to get the parts: the BUZ71 transistor is available from Jaycar or from Geoff Wood Electronics. An etched PCB can be obtained from RCS Radio Pty Ltd or from Acetronics PCBs.

Fig.2 shows where the parts are mounted on the board. In all, there are just 13 components to be installed. The order is of no consequence although we suggest that the terminal block and the 1000uF capacitor be left till last.

Note that although the PCB has provision for reverse polarity protection diode D3, some solar panels are supplied with a suitable diode mounted internally. If this is the case, D3 should be replaced by a wire link — there is no need for duplication. In fact, if you include D3 in this situation, you're wasting power.

Once the PCB has been completed, it can be given a quick check before installation in the boat. To do this, connect the battery and the motor by referring to Fig.2 and the underside of the PCB. Each of the slots for the terminal block is labelled with a code; eg. "m-" and "m+", meaning motor negative and motor positive respectively.

It's then simply a matter of shorting the i1 and i2 terminals together. The motor should immediately switch on and continue running for approximately 30s after the short is removed.


View of the assembled PCB. It should be installed in a waterproof box.

Installation

The circuit should be mounted in a sealed box to protect it from moisture, especially if the boat is operating in salt water. Since the PCB is so small, any one of a number of standard project boxes would be suitable. In fact, the smallest zippy box would be ideal and this should be waterproofed using a silicone weather sealant.

Since each boat will present a different case for detecting the water level, we have left this to the constructor's discretion. A float and mercury switch arrangement would probably be the most reliable. The float, however, would have to be quite small for a small V-bottom boat.

As an alternative to the mechanical system, a moisture detector could be used as stated previously. In the simplest case, this would amount to mounting two probes near each other (at a low point in the hull), with one connected to i1 and the other connected to i2. Salt water flowing over the probes would create a low resistance path between them, triggering the circuit.

For fresh water, the 10k pullup resistor may have to be changed to a higher value to ensure reliable triggering.

Using the above method would undoubtedly be successful in the short term, but deposits (especially salt) may lead to false triggering. A more serious limitation is that if this system was set up for salt water, it may not trigger in fresh water. The boat could be at risk during periods of heavy rain.

Irrespective of the water detector used, make sure that the circuit does not trigger the pump for an unrealistically low level of water. Instead, the detector should be arranged so that the pump turns on at a preset level and just manages to pump the water down to the inlet. ⓔ

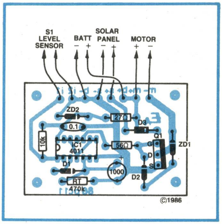
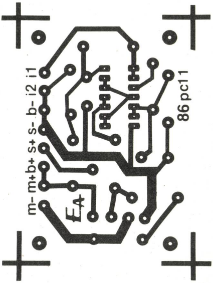


Fig.2: parts layout for the PCB. External connections are via an 8-way terminal block.



Here is an actual-size PCB artwork.

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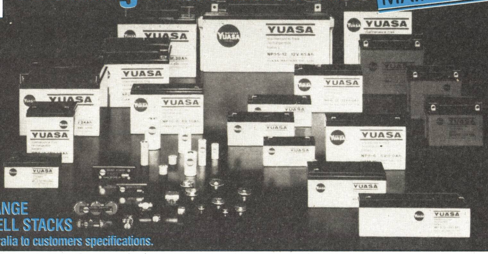

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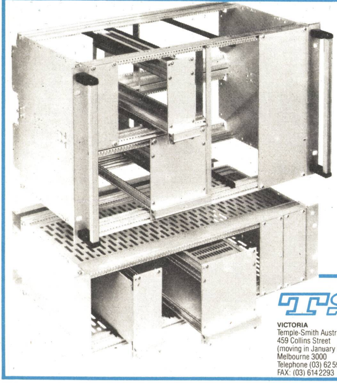

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An introduction to hifi Pt.9

Digital technology

Procedures, equipment, terminology

Having discussed the background and the broad principles of digital audio recording and playback, we look now at the procedures and equipment commonly involved and explain some of the relevant terminology — including unfamiliar words like "foldover", "aliasing", "granulation noise" and "dither"!

by NEVILLE WILLIAMS

As a first reaction, it might be assumed that the prospect of digital recording would not affect normal analog signal source arrangements involving the performance and acoustics, the type, number and placement of microphones, cabling and preamplifiers, signal control and mixing.

In fact, the exceptional acoustic "transparency" of digital recording and replay systems — the result of very low inherent noise and distortion — tends to expose subtle production faults which have hitherto been masked by the limitations of traditional analog signal sources and methods.

As a result, conductors, producers and recording engineers have become more sensitive to the intrinsic sound of the orchestra, and to the modifying effects of acoustics, microphone techniques, panel processing, equipment quality, &c. Considerable efforts have thus been made to upgrade the analog equipment in which the multi-channel signals exist prior to digital encoding.

Supersonic filtering

Immediately before the sampling process (Fig.1) the analog signals pass through low-pass filters to remove frequency components beyond the nominated 20kHz passband. The reason for so doing is reminiscent of the "foldover" effect, often encountered in conventional analog tape recorders.

In analog tape equipment, if one records and replays a gliding tone signal, passing through and beyond the system high-frequency cut-off, heterodyne whistles may be heard in the background, diminishing in frequency as the gliding tone moves upwards. They result from beats between harmonics of the input signal and the recording bias.

The effect is not directly apparent with normal program input, but spurious intermodulation products must inevitably be present in such recorders.

In the case of digital recording, a different set of circumstances can give rise to a similar effect.

As pointed out in the last article, signal sampling is valid only for frequencies of less than half the sampling rate. For this reason, digital systems intended for signal frequencies up to 20kHz invariably use a sampling rate in excess of 40kHz.

If signal components greater than half

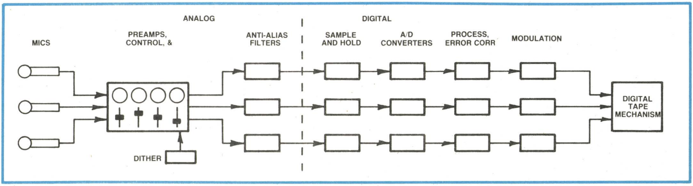

Fig.1: Depicting in block schematic form the signal chain for a digital recording system. In a full-scale studio recorder, sockets on the rear panel accept multiple balanced analog inputs from the central console, all subsequent filtering and processing being an integral part of the recorder.

the sampling frequency are fed into such a system, their sampled resultants will be invalid and liable to be wrongly decoded as spurious signals, including difference frequencies between the sampling rate and its harmonics, and the inadmissable components.

While such "alias" (wrongly identified) components may be very small, they are nevertheless unacceptable in the clinically clean environment of a digital recording. Hence the need for sharp cut-off "anti-aliasing" filters in the analog signal output circuits.

An ideal top-cut (or low pass) filter would exhibit a vertical "brick wall" characteristic, with no phasing or ripple effects on the frequencies which it passes and no trace of those which it rejects. Practical analog filters fall short of the ideal, however, providing grounds for abstract argument by:

- "Golden-eared" hifi buffs who profess to hear filter effects inaudible to others, and
- Engineers who debate filter theory in terms which no one else can comprehend!

Sample and hold

The digitisation process which follows (Fig.1) is often dismissed, rather summarily, as simply involving the acquisition of instantaneous samples of the incoming analog signal — one sample every 25μs or so. It is not always appreciated that, during that period, a 20kHz signal would pass through a complete half-cycle, rendering it meaningless to feed such a waveform directly to a quantisation circuit.

The job of acquiring a more valid "instantaneous" sample falls to "sample and hold" (S/H) circuitry, which samples the incoming waveform in something less than 5μs (the acquisition time) and holds the determined value until the A/D (analog to digital) converter has matched it to the closest increment in the quantisation ladder.

Essentially, an S/H involves a small capacitor which is electronically switched, by "sample" commands, to a buffered signal source long enough for it to acquire a charge equal to the instantaneous value of the signal. This is then fed to the A/D converter input to permit the acquired signal value to be quantised.

The basic principle is simple enough; the essence of an effective design lies in achieving the fastest possible response to the clock "sample" command, the shortest possible acquisition time, and the minimum "droop" or loss of acquired charge during the "hold" period. (Fig.2).

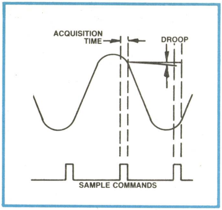

Fig.2: A sample and hold circuit must sample the instantaneous amplitude of an analog signal in the shortest possible time and hold it, with a minimum of droop, for the value to be quantised by the A/D converter.

Conceptually, a sample and hold circuit transforms an analog signal into unambiguous, readily measurable steps. It remains for the actual A/D converter to relate those steps to discrete voltage increments identifiable by digital words.

Analog-to-digital

A-D conversion is a highly specialised procedure, the finer details of which are frequently secreted within the intricacies of dedicated LSIs (large scale integrated circuits). Most, however, operate on one of two basic principles, the first thing being referred to as SAR (successive approximation register), an ultra high-speed variant of the old "pick a number" routine.

Presented with each new sample, a SAR converter first compares it with the MSB — the most significant bit, representing the largest increments in the reference stack — and decides if the MSB is "too big" or "too small". If too big, the MSB is rejected and the left-hand digit of the 16-bit output word is set to "0". If too small, the MSB is retained and the left-hand digit set to "1".

The SAR then tries the next significant bit, rejecting it or adding it to the first as necessary and setting the equivalent digit accordingly. So the process continues through to the LSB (least significant bit) to optimise the match and complete the 16-bit word.

The main alternative design approach involves the integrating principle where, on receipt of each new sample, a precision capacitor begins to charge at a predetermined rate from a constant current source.

A crystal controlled "clock" circuit registers the time it takes for the charge to equal the sample signal; it then produces an output reading in binary notation, not as so many microseconds, but in terms of the voltage level that the charge would have attained in the elapsed time, thus providing the output word.

Practical integrating type converters use two charging circuits (described as "dual-slope" or fine and coarse "ramps") each of which outputs 8 bits of the quantising word. The two are merged to provide the full 16-bit word for each sample.

Both SAR and integrating type A-D converters are capable of meeting present day needs. Linearity is very good, as indicated by the very low harmonic and intermodulation distortion levels exhibited by virtually all current digital equipment.

But what is dither?

Digital systems have been open to considerable debate concerning their behaviour when encoding very small signals — especially those which approximate the amplitude of the least significant bit.

We can postulate that, in a noise-free channel, a signal of that magnitude may be treated, somewhat randomly, in various ways:

(1) It may fall below the quantising threshold and be ignored;
(2) It may repeatedly cross the quantising threshold and be encoded as if it was actually a low level square-wave signal.

You can argue that, in practical situations, the fate of signals in the −95dB region is academic. On the other hand, critics insist that what happens to very small signals is indicative of a wider problem: one that, in their judgement, produces a "gritty" sound, sometimes referred to as a "granulation" effect or "granulation noise".

Fortunately, there is a simple and almost automatic way around such problems: the addition to the original analog signal of a very small amount of broadband noise — described as "dither" — not simply to mask the quantising errors but, as it transpires, to correct them!

A case can be made for a noise component (or dither) of a particular type but, in practice, ordinary analog "white" noise is adequate.

The effect of dither

With dither present, the quantising errors, responsible for the above problems, are no longer a simple artefact of the original signal and the quantising process. Errors which would be predictable and cumulative with a smooth input waveform are "randomised" when the waveform is carrying a band of white noise.

The resulting — and similarly randomised — binary quantisation words no longer specify to the decoder predictable, stepped waveshapes with well defined harmonics and intermodulation products; instead, they specify something much less angular — more like the original signal, carrying a quota of broadband noise.

The role of dither is difficult to illustrate graphically but Figs.3 and 4, reproduced from EA for July 1984, show the dramatic effect, at low signal levels, of adding white noise equal to one third of a quantising increment. Harmonic distortion (Fig.3) and intermodulation (Fig.4) subside into the broadband noise at about −27dB relative to the already small signal.

The diagrams come originally from a paper presented to the Canadian AES, in 1982, by J.B. Vanderkooy and S.P. Lipshitz. The authors go on to say: "With sufficient dither, a digital system loses all its digital artefacts."

They further suggest that, whereas early and less pretentious 12-bit and 14-bit systems commonly needed added dither, the increments in a 16-bit system are so small that natural analog noise ahead of the A/D converter is usually sufficient to provide adequate dithering. Hence our earlier reference to the way around the problem being "almost automatic".

At the same time, it is not something that should be left to chance, which is why a dither source is shown in Fig.1 feeding into the analog system.

Contrary to what you might expect, the addition of dither does not restrict the dynamic range. In effect, optimum dither adds an analog-like "noise floor" below the LSB in which signals can still be subjectively discerned.

Formatting the data

While the binary output from an A/D converter can be handled conveniently enough with logic (computer style) circuit modules, it is not really suitable for storage, recording or transmission in that form.

For one thing, the 16 bits comprising each binary word appear simultaneously as a "parallel" output from the A/D converter; they need to be reorganised into "serial" format — one bit at a time in the desired sequence.

Furthermore, to obviate ambiguity during playback, a synchronising code in the form of a unique bit group must be inserted into the serial data stream, to identify the beginning of each new word and word group. (Synchronising code in a data stream has been likened to punctuation marks in printed text).

As well, check codes and parity bits are added and the data is "interleaved" or dispersed in the data stream to facilitate error detection and correction during playback. More on this later.

In studio situations involving multiple microphones and multi-channel recorders, the data streams for individual channels are kept separate, for recording in individual tape channels. One or more supplementary information channels may carry timing signals, "address" cues, &c, to facilitate crystal locked playback, along with computer controlled editing, mix-down and dubbing.

If two-channel "stereo" information needs to be merged into a single channel for recording (or transmission), normal practice is to employ time-multiplexing, with formatted bit packages from each channel recorded or transmitted in sequence for later separation and decoding. Time-multiplexing doubles the bit rate, however, and is only practical where the recording or transmission system can accommodate the extra bandwidth.

Modulation codes

Conceptually a data stream is a sequence of on-off states, ie, a rectangular waveform.

In the course of recording or transmission, however, the neat, rectangular waveforms may be degraded so that up/down transitions between the two states become a more reliable feature of the data stream, and the basis on which the original pulses can ultimately be reconstituted.

For this reason most digital systems

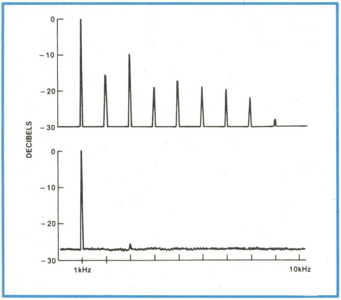

Fig.3: In quantising very low level, noise-free signals, the harmonic distortion can be very high. With dither (lower diagram) it subsides into the noise at about −27dB below the already tiny signal.

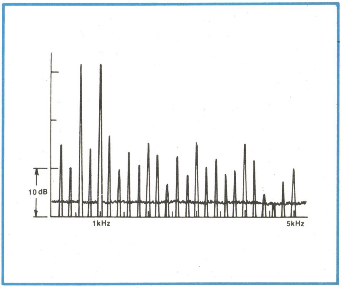

Fig.4: The prominent spiky pattern shows intermodulation products when two low-level signals are quantised. With dither, the spikes also become part of the noise at about −27dB below the small signal level.

employ so-called "modulation codes", which place emphasis on the transitions rather than the states, to take best advantage of the bandwidth available. The data stream is modified (or modulated) in accordance with the selected code for recording or transmission and, upon replay or reception, demodulated and reconstituted.

Without seeking to discuss the various codes, it may be helpful to list certain ones so that the terms will at least be recognised.

NRZ — Non-return to zero.
NRZI — Non-return to zero inverted.
MFM — Modified frequency modulation.
EFM — Eight-to-fourteen modulation.
HDM-1 — Used in modern studio recorders.

Correction codes

While two-state digital information is "robust" by nature and substantially free from limitations of the analog kind, there is always the possibility that some of the densely packed data bits or groups of bits will be lost due to flaws in the recording medium: eg. coating drop-outs or minute surface particles in the case of tape; scratches or other surface defects in the case of compact discs.

To forestall such problems, and the resulting "clicks" and "plops", digital systems normally include provision for correcting or concealing aberrations during playback — something that has not been practical in analog technology. The effectiveness of such measures contributes in no small degree to the noise-free qualities of digital recordings.

Error correction involves a number of simultaneous measures including parity bits, coding, interleaving, interpolation and muting.

Parity and interleaving

By making provision for extra non-data ("redundant") bits in the data stream it is possible to provide an indication of the accuracy of binary words recovered from the tape.

By increasing redundancy (more check bits) and by more ambitious processing, it becomes possible both to identify and correct most bit errors.

A further measure involves "interleaving" or dispersing individual data bits or words in a structured way, so that their sequence in the data stream is radically changed.

If a "burst" error then creates a major fault in the data stream, the affected bits, after de-interleaving — or re-distribution — become scattered small errors, subject to individual correction by parity checks, &c.

Using principles such as these, engineers have come up with a range of error correction codes such as CIRC (Cross-interleave Reed-Solomon) code, used for compact discs.

Interpolation, muting

If a "burst" error is of such magnitude that, at best, it is not correctable, the logic circuitry operates to give the missing signal amplitude words interpolated values derived from adjacent valid words.

If interpolation cannot conceal a particularly serious fault, a digital muting circuit cycles the suspect word group through zero amplitude, effectively transforming a click or a plop into brief and hopefully unobtrusive silence.

In practical situations, the muting circuit is very much a last resort. In compact discs, for example, elaborate CIRC encoding can correct burst errors involving up to 4000 bits (2.5mm of track length). This is extended to 12,300 bits (7.7mm of track) by adjacent sample interpolation! (In practice though, no CD player will track a disc with such a surface defect).

Data packing density

While the above figures indicate the effectiveness of digital error correction measures, they also highlight the packing density of digital audio data — of the order of 1500 bits per millimetre — a figure which is valid for both optical and magnetic media.

In terms of frequency bandwidth, and allowing for the bit-rate economy of "modulation" systems referred to earlier, high quality digital recording requires many times the bandwidth of an analog system, for a given audio response — typically Megahertz.

This presents no great difficulty with compact disc because, in the first instance, laser optical technology was developed for video recording. Much the same is true of tape systems using video style helical scanning.

However, for stationery head multichannel linear recorders, normally preferred for functional reasons in studio situations, a quantum jump in tape, head and circuit technology has been necessary.

To ensure intimate contact with head gaps, for the best possible transfer of densely packed data, digital tape uses a base film little more than half the thickness of ordinary analog tape. This is possible because residual cross-talk, due to print-through, is normally rejected by a digital system.

The coating, too, is different, commonly a cobalt modified gamma ferric formulation, with a coercivity level of between 700 and 1000 Oersteds and able to retain a "robust", saturated pulse pattern.

While the particles must still be needle shaped and positioned lengthwise along the tape, for the normal magnetising format, they must be of the smallest practical dimensions and applied in a thin but dense coating to minimise demagnetisation and the loss of high frequency signal components.

As to magnetic heads, the "thin film" concept, with the essential elements printed on substrate, seems set to take over from the conventionally assembled variety. Also in view is "perpendicular" recording, with super-fine particles positioned vertically in the coating and offering a dramatic potential increase in particle — and bit — density.

Practical recorders

The latest generation of stationary head recorders uses the so-called

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"DASH" (Digital Audio Stationary Head) format, the Sony PCM-3324, pictured in the last chapter, being an example.

The subject of an agreement between major professional recording equipment manufacturers, the DASH format establishes standards for new and developmental professional digital recorders from 2-track to an ultimate 48-track, using either 12.7 or 6.35mm tape.

An interesting aspect of the DASH format is that, in certain configurations, it provides for the use of one, two or four separate tracks to record individual audio channels. Each track has its own extensive error correction but the use of multiple tracks makes it possible for the playback circuitry to momentarily discard a signal which exhibits an uncorrectable burst error.

So to playback

The steps necessary to reproduce the original analog signals are as indicated in Fig.5, which shows three audio channels only.

Digital signals recovered from the tape are by no means copybook rectangular waveforms but this is of little concern. As long as the signal contains unambiguous up-down transitions, it is possible to readily reconstitute the pulses, as originally recorded, without loss of information.

Following preamplification and waveform re-shaping, the data streams are fed to demodulators which reverse the original modulation and rearrange the data into its wider-band pre-taping format.

At this point, timing signals derived from the tape are fed to a tape drive servo control system, along with reference pulses from an inbuilt crystal clock. The servo system holds the capstan at the precise speed necessary to maintain synchronisation.

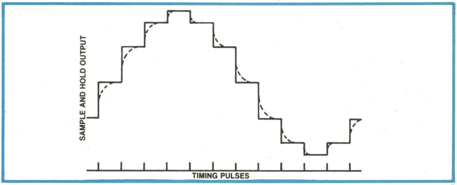

Fig.6: The solid line shows an idealised rectangular output from the final sample & hold stage following the D-A converter. A practical and commonly preferred "integrating" S/H circuit delivers an output to the low pass filter as per the dotted line.

At the same time, the data stream is processed to sort out other information signals, the basic data and the parity bits, and to give effect to error correction procedures. If the data stream has been time-multiplexed to accommodate left/right stereo signals, these are separated and time synchronised by passing the leading signal through a delay line.

At this juncture, the recovered binary words could conceivably be processed into analog but with the possibility that they would introduce timing errors — hence flutter — due to slight "hunting" or jitter from the tape servo control system.

To forestall this possibility, word bits for the respective channels are fed into memory banks, maintained about half-full by the servo system. They are "clocked" out by crystal-derived timing pulses, independently of the input feed. Wow and flutter is thereby eliminated, being typically specified as "unmeasurable".

Back to analog

As part of the D-A (digital to analog conversion) procedure, the serial data streams must again be converted to the required parallel format and then fed to the D-A converter.

Output filtering

An effective low-pass filter, set at or below half the sampling frequency is an essential feature of a digital system, if frequency components are to be removed which represent the difference between a "staircase" waveform from the D-A converter and a "smooth" analog signal.

Once again, a vertical "brickwall" filter, free of phasing effects, would be ideal — if it could be achieved. In general, practical output filters represent a compromise that offers adequate high frequency attenuation, with tolerable phasing effects in the passband.

More ambitious designs use digital filtering to discriminate against the high frequency components while they are still in digital form, thereby reducing the reliance on the analog filter.

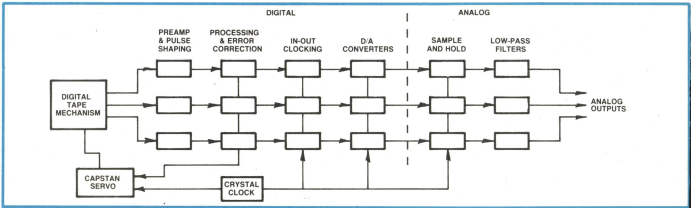

Fig.5: Illustrating the signal processing sequence involved in recovering the original analog signals, again an integral part of a multi-cha nel digital studio recorder or, for that matter, of a domestic compact disc player.

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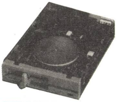

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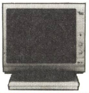

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What's new in display technology?

Display technology is growing rapidly as electronic equipment becomes more and more complex. In this article we review the six major display technologies presently in use and cover recent developments.

by LEO SIMPSON

In October last year we presented a major article on the subject of liquid crystal displays. This time around we shall look at the major display devices presently in use. In addition to LCDs, they include light emitting diodes (LEDs), vacuum fluorescent displays (VFDs), plasma discharge displays, electroluminescent displays and cathode ray tubes (CRTs).

All these devices can be and are used as information displays for computers or for dedicated microprocessors in home and business equipment such as microwave ovens, VCRs and hifi equipment, photocopiers and facsimile machines, electronic tellers, ticket machines, drink dispensers, petrol pumps and so on. It seems as though just about every piece of electronic equipment these days has some sort of digital, alphanumeric or dot matrix display.

The reason why these displays have become virtually mandatory is that equipment is becoming more complex and so needs to give the user more information on how it is functioning. At the same time, as dedicated microprocessors in all this equipment continue to become cheaper and yet ever more powerful, it is becoming much easier to incorporate fancy displays.

In personal computers, there is a drive to produce terminal displays which have more brightness, greater legibility and higher resolution for text and graphics images. At the same time, there is a continual search to reduce the overall bulk and weight of the visual display unit and to lower its power consumption.

Light emitting diodes

Discounting early display devices such as numerical indicator tubes and cathode ray tubes, the light emitting diode was the first to be widely used in information displays. They were first introduced as single light emitting diodes but then became more specialised as they were incorporated into seven- segment displays and bar graph displays.

In these applications, LED displays have the advantage of being attractive, highly visible and legible in all light conditions except bright sunlight, easily driven by low voltage solid state circuitry and available in a range of colours such as red, orange, green, yellow and yellow/green.

For single lamp devices, all the above colours are available plus two-colour units (which incorporate two separate LEDs) and just recently, Siemens have introduced blue LEDs.

LEDs are available in a wide range of packages including surface mount. As well there are two broad categories which most manufacturers produce: standard and high-brightness or high efficiency. The latter types can be very bright, with light outputs up to as much as one candela. They can be used in two ways: first to obtain a very bright display and second, to obtain adequate brightness at very low operating currents of only a few milliamps.

As well as producing a wide range of single LEDs, seven segment LED displays and alphanumeric displays, several manufacturers have a range of LED bargraphs and LED-illuminated legend panels.

Multiplex drive

While single LEDs, bar graphs and legends can be driven with simple circuitry, it is not simple for seven segment displays and alphanumeric displays. Since these are generally used in arrays of four devices or more (as on clock and frequency displays on many appliances), it is customary to use a multiplex system of drive.

In the multiplex method of connection, all the respective segments in the displays are connected together, so that for a four

This moving text display uses LEDs and comes from Text Lite.

digit display there are seven segment lines and four cathode lines (assuming that they are common cathode displays). Thus there are only eleven lines needed to drive the display rather than the 32 lines which would be needed if each digit was separately driven.

The method of multiplex drive is as follows: Each cathode line is turned on separately and when it is energised, the respective segments for that digit are also turned on to illuminate them. The process means that each digit is turned on sequentially very briefly, at a rate of about 3000 times a second. If you were to slow the process down, the digits would each light sequentially with a duty cycle of approximately 25% (ie, each digit is on 25% of the time).

As well as saving on connection lines, multiplex drive of LED displays also results in a brighter-looking display for a given current consumption (compared to direct drive).

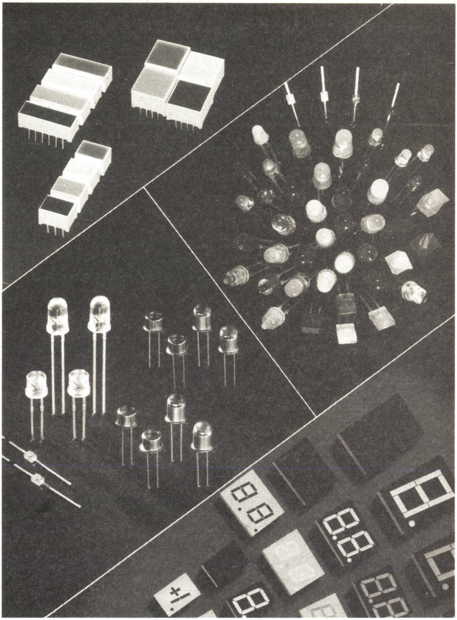
Alphanumeric displays are very similar to seven-segment displays except that the former have more segments so that they can show all letters of the alphabet as well as numerals from 0 to 9. They can be multiplexed in a similar way.

A step up in complexity is brought about by dot matrix displays which can display all ASCII characters in a matrix of LEDS consisting of five columns and seven rows. Again, these are multiplexed as direct drive would be impractical.

On an even larger scale there are the moving text displays used in theatres, retail stores and clubs. These may be several metres long and employ thousands of high brightness LEDs. The displays are driven by a small computer which may be programmed by a detachable keyboard. The most "intelligent" of these displays can even show company logos such as those for Ford and Coca-Cola.

Advantages and disadvantages of LEDs

The advantages of LED displays are self-evident. They are bright, easily read and available in a number of different colours, as outlined above. Their disadvantage is that they consume relatively large amounts of current. Hence they are not suitable for very complex displays such as the now standard personal computer 80 column by 25 rows of ASCII text. Such displays are actually large dot matrix arrays with 200 rows and 640 columns or a total of 128,000 picture elements. Clearly, such a large display would be impractical. This is why liquid crystal, plasma and electroluminescent technology has come so far.



Light emitting diodes (LEDs) come in various shapes, sizes and colours and are also available as surface mount packages.

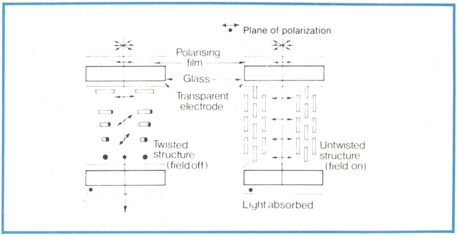
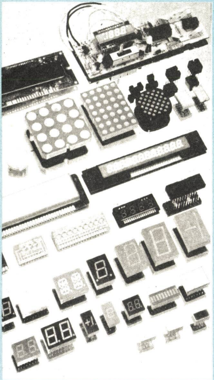


Fig. 1: The twisted nematic effect in an LCD structure with the electric field on and off.



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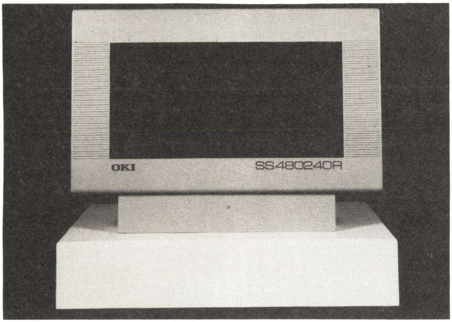


This graphic type plasma display from Oki runs off DC power.

Vacuum fluorescent displays

After LED displays, vacuum fluorescent displays are probably the most popular type. They are and have been used in countless digital clocks, VCRs, AM/FM tuners, microwave ovens and so on. In these cases they are typically four digit alphanumeric or seven-segment displays coupled with annunciators (ie, illuminated legends) to indicate various modes of the particular appliance.

The big reason why they have been so universally popular is that they are so attractive with their soft blue or blue-green lighting. They are actually based on a very old technology, being similar to that used in the much-loved "magic-eye" tuning indicator used in old valve radios and to some extent as a level indicator in early tape recorders.

As such, the vacuum fluorescent technology is based on the thermionic tube and in particular, on the directly heated triode. The typical display has a filament which is in the form of a mesh across the inside of the front glass. Then there are grid lines, one for each display segment or element and finally, the anode lines which actually are fluorescent material deposited on the inside of the back panel of the display.

The filaments are heated by passing current through them and so they emit electrons. The electrons are accelerated to the anodes depending on whether the

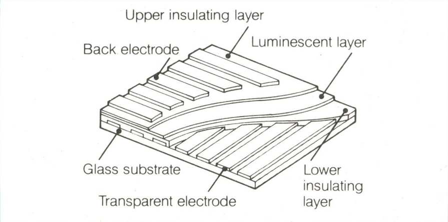


Fig.2: the structure of an Electro Luminescent display unit.

associated grids are slightly positive, to enable electron flow, or negative, to stop current flow.

Such vacuum fluorescent displays require an anode supply of around 135 volts DC as well as a filament supply. The driver circuitry need not supply any current though, since it is used to control the grid lines. Again, the multiplex drive method is used to reduce the number of connections.

Recently, the Japanese manufacturer Futaba has developed a high resolution vacuum fluorescent display module which will be able to compete directly with large LCD and plasma displays. The new VFD module has 640 x 400 dots with a dot pitch of 0.28 x 0.28mm. The panel comes with a 32-bit control board which converts standard RGB signals intended for a video monitor into the drive signals for the display.

Liquid crystal displays

By far the most efficient display technology is the liquid crystal display. It uses far less current than any other display technology and only requires a few volts drive. A comprehensive report on liquid crystal displays was featured in the October 1985 issue of EA but for those who did not see that article, we will give a brief summary here.

Liquid crystal displays (LCDs) first made their appearance in watches and calculators but now the list of applications has expanded to embrace virtually every electronic device that has a readout. Unlike all other displays, LCDs are passive. They do not emit light themselves but modify incident light which may be scattered, reflected or transmitted by the display.

In a typical LCD , the liquid crystal (an organic fluid which can exist in a "mesophase") occupies the space between two parallel glass plates which are separated by a distance of just a few microns. The inner surfaces of these glass plates have transparent electrodes which define the characters to be displayed. The electrode surfaces are treated to induce the long molecules of the LCD fluid to align in one direction, parallel to the plates.

This is how the common LCD description, "twisted nematic" arises. Nematic means thread-like and so twisted nematic LCDs have the induced direction of the front and back plates at right angles to each other. Hence, the liquid crystal structure is twisted through 90 degrees from the back plate to the front plate.

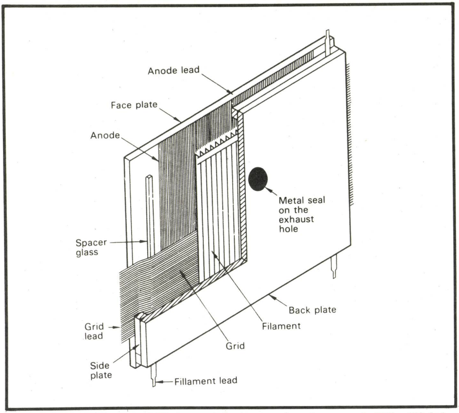
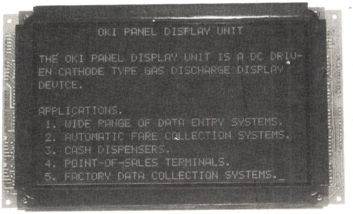


Fig.3: A Vacuum Fluorescent Display module structure for a large panel (640 x 400 dot).



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What's new in display technology

An EL graphics panel from Sharp.

Now, and this is crucial to the whole process, if a voltage is applied between the two plates, the crystal struture of the liquid is broken as the long molecules align themselves parallel to the electric field.

Also crucial to the operation of LCDs are the polarising filters which are usually fitted over the front and back plates. These filters are also arranged at 90 degrees so that no light can pass through them. Hence, when voltage is applied between the plates, light passes through the front polarising filter, through the aligned liquid crystals and thence the rear polarising filter where it is absorbed.

When no voltage is applied, light passes through the front polarising filter, then through the helix crystalline structure of the liquid thereby having its planer of polarisation rotated by 90 degrees. This allows it to pass through the rear polarising filter, be reflected from the rear mirror coating and back out the front. Hence, where no voltage is applied, the display appears silvery grey.

The above description applies to the most common LCD, the twisted nematic reflective type. Variations on the use of polarising filters and mirror coating allow other modes to be used such as transmissive (used with back-lighting) and transflective which is a compromise allowing both reflective and backlit modes.

Colours can also be added to LCDs either by the use of colour-selective polarising filters, coloured filters, coloured back-lighting or dichroic dyes in the liquid itself. The last named are known as guest-host displays and are capable of brilliant colours.

Multiplexing

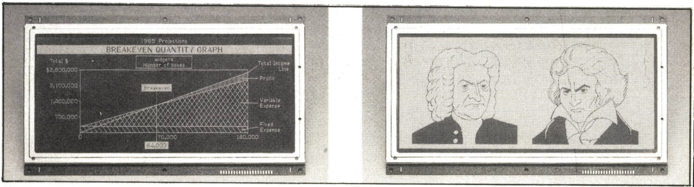
A comparatively recent development in LCD technology is the use of multiplex drive. At first all LCDs were directly driven but for large complex LCDs as used for personal computer screens this is impractical, as it is with any other large display. The catch with LCDs is that multiplexing reduces the contrast and legibility of the display and it gets worse as the multiplex drive ratio (ie, the duty cycle) increases. For the most complex 640 x 400 pixel (picture element) displays, the multiplex ratio can be as high as 100:1 and the contrast ratio may be less than 3:1 which means that it can be almost unreadable under anything but ideal conditions.

During the last year, the manufacturers have improved this aspect of LCDs with the introduction of the super-twist display. This is a variation on the twisted nematic display whereby the crystalline helix is rotated through 270 degrees instead of 90 degrees. The resulting displays are certainly more legible under a wider range of lighting conditions but they still have a considerable way to go before they can really compete with the CRT (cathode ray tube) for a video display.

Plasma displays

Apart from display contrast, the big problem with LCD screens is the restricted viewing angle. Move just slightly off- axis to the display and its overall visibility diminishes drastically. This is the reason that plasma displays are becoming more widespread even though they are more expensive than CRTs or LCDs.

Interestingly, the plasma display is another example of an old technology dressed up in a new form. In fact, the plasma display is a very refined version of the gas discharge or neon tube. Each dot in a plasma display can be likened to a neon tube. It has an anode and a cathode with a gas in between at low pressure. This gas is a mixture of neon and a small amount of argon or xenon. A high volt-



Above are two LCD modules from Oki.

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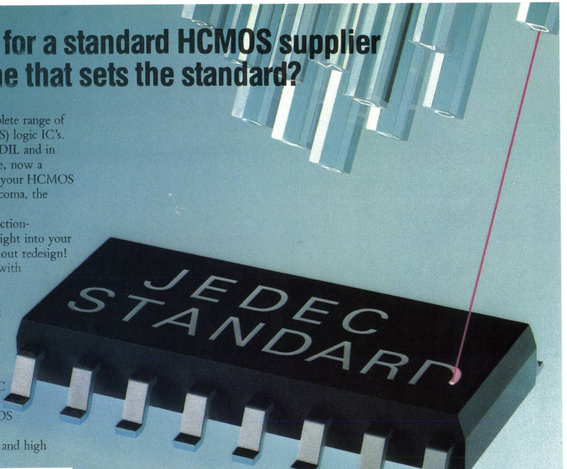

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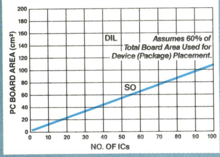

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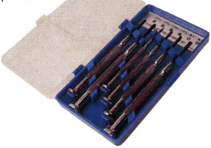

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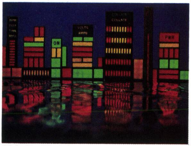
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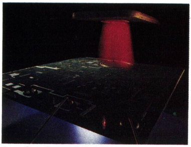
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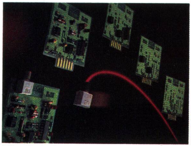
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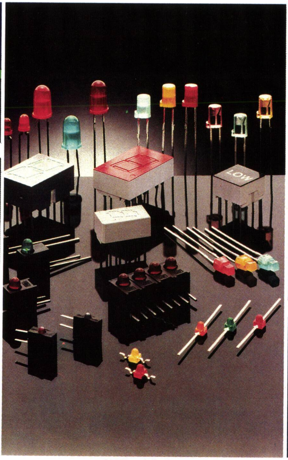

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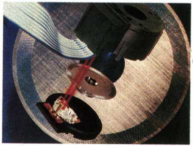
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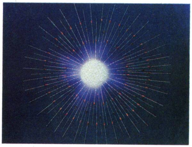
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What's new in display technology

age is applied between the anode and cathode which causes the gas to ionise and glow. Thus there is light output while ever voltage is applied.

In practice, practical dot matrix plasma displays are much more complicated than this simple description would indicate. Again, for practical displays, the multiplex drive method is used. For a 640 x 400 dot display there are 640 cathode lines and 400 anode lines (or vice versa). So there are effectively 256,000 plasma cells which are progressively scanned to build up the display. The anodes and cathodes are laid out in a matrix of long thin conductors embedded in glass plates. The gas is contained in tiny cavities at each intersection which are each divided to form three separate cells.

One of these is the main display cell while the other two are auxiliary cells — the constant discharge (or DC pilot) cell and the scanning cell. The constant discharge cell provides a constant stream of ions to neighbouring display cells and auxiliary cells to effectively "bias" them. For their part, the auxiliary cells are used to transfer the discharge across the whole display. They are used because the main display cells would otherwise take too long to turn on from cold, which would result in a flickering display.

As with other large displays, plasma panels are supplied complete with all the interfacing circuitry so that they can be controlled with standard RGB signals intended for a video monitor. While orange is the most frequently seen plasma colour, these displays are also available in green.

Custom made plasma panels are currently available in very large sizes, up to as much as half a metre square in some cases. IBM has a plasma screen unit which will simultaneously display four video screens. And the Australian submarine project envisions a map table based on a large plasma panel.

Apart from its large size, non-critical viewing angle, high brightness, and lack of flicker, the plasma display is attractive because it is relatively compact, with a small front to back dimension of around 50mm or so. Its main drawback is its relatively high power consumption which can range up to 200 watts for a large panel. Even so, their compact size is making them popular for the more expensive portable personal computers such as those made by Toshiba and Panasonic (Matsushita).

Electroluminescent panels

In the early sixties, electroluminescence or "cold light" was expected to be the light source of the future. It seems that as far as that prediction is concerned, the future has yet to arrive but they have been developed into an alternative display medium by companies such as Sharp and IEE.

An electroluminescent (EL) display relies on the property of some substances to give off light when subjected to a sufficiently high voltage. The substance used in today's panels is zinc sulphide doped with manganese which produces an easily readable amber display.

By sandwiching a layer of the luminescent material between sets of horizontal and vertical electrodes, a voltage can be applied across small areas of the panel to make it glow. So whenever a row and column electrode are energised, the material at the intersection glows to produce a dot on the display. As with other panels such as LCD and plasma, EL panels therefore lend themselves to multiplex drive and the manufacturers package the panels complete with all interface and power supply circuitry.

Power consumption is relatively low, with large panels consuming less than 20 watts overall.

Also as with other panel displays, the EL display is based on a glass substrate. But since it does not employ a vacuum, a fluid or a gas at low pressure, it is claimed to be more rugged and able to be used at very high altitudes, making it suitable for use in military aircraft.

The EL panel has additional advantages of even higher brightness than plasma displays, wider viewing angle (virtually the same as this page) and a contrast ratio of up to 100:1 (also comparable with this page). However, the present high cost of EL panels tends to limit their use to very specialised applications, mostly in defence.

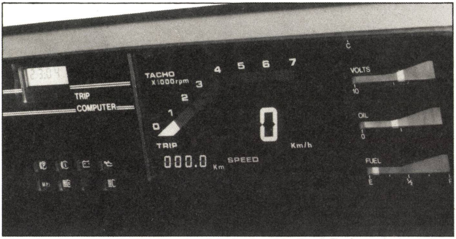
And the winner is: the CRT

When all is said and done though, the cathode ray tube is still by far the most popular and efficient display for use with computers. It is capable of much better resolution than competitive displays and is simpler to drive in that it does not require multiplex circuitry. In monochrome form it is available in green or amber and of course, it is the only high resolution display format which is available in colour.

Because the CRT has been evolved over many years and used in such large quantities for television receivers, the technology is now highly refined and very reliable. But whereas all colour television receivers now use self-converging tubes with in-line guns, the higher resolution colour monitors for personal computers still use shadow-mask tubes with the triad gun format. This is somewhat harder to adjust for optimum performance but is capable of the higher resolution needed for today's very detailed computer displays as used in computer-aided design software.

While the CRT still tends to have a big lead in overall performance compared to other display formats, it still has a number of drawbacks. These include weight and bulk of the tube, the tendency to produce electromagnetic interference (from the sweep circuitry), relatively high power consumption and lack of ruggedness (unless a ruggedized version is specified).

Even so, the CRT is likely to remain king for at least the next five years or so, and perhaps for a good time beyond that. EA



Above is a prototype LCD dashboard module developed by Bosch Engineers in Australia.

For experimenters:

DX reception with small AM radios

DXing is the art of listening to radio stations over long distances. Here's how to increase the number of stations that you can receive.

by STEVE PAYOR

The AM-3 radio (EA, February 1986) used a ZN414 integrated circuit for the "front end". One of the problems with this IC is the lack of a wide range of Automatic Gain Control (AGC), and for this reason the AM-3 has a manual gain control to trim back the gain for strong signals. But what about *very weak* signals?

With the ZN414, any signal input below 50μV will not be heard at all, because it is below the threshold of the detector. This limits the useful range of the AM-3 to a hundred miles or so under good conditions.

For those constructors of ZN414 radios who live in remote areas, or who just want more signal from their favourite station, the following ideas will bring the signal up to a level which can only be described as "loud".

Furthermore, no modification to the receiver is necessary — you don't even have to open up the case!

Picking up more signal

Firstly, string up 10 to 20 metres of wire as an aerial. Insulated hookup wire will do fine. It should be as high as possible, but the picture rail will usually suffice. Connect one end directly to a good RF earth: a grounded water pipe is best, but the case of an *earthed* mains appliance will do.

The RF currents now flowing up and down the wire should be strong enough to be picked up by simply holding the ferrite rod aerial near the down-lead (Fig.1).

For more signal, wrap the wire once or twice around the radio as shown in Fig.2. Note: in any metropolitan area, two turns will completely saturate the ZN414.

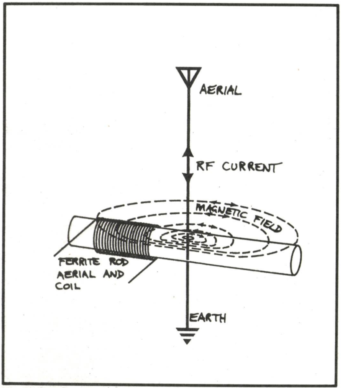


Fig.1: Coupling in a signal from an external aerial can be as simple as putting the radio near the down-lead.

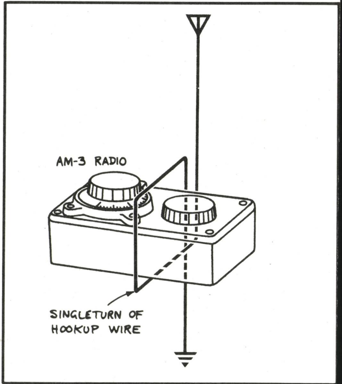


Fig.2: Stronger signal coupling can be obtained by wrapping the down-lead around the radio.

Tuning the aerial

For more selectivity, use an aerial tuning coil. This is the reception technique which allowed early radio receivers to perform so well without any form of electronic amplification.

To make a suitable aerial tuning coil, you will need a piece of cardboard tube which will comfortably slide over a length of ferrite rod. On this tube wind a coil of 120 turns of enamelled copper wire. (Note: Most parts suppliers stock a small rectangular ferrite rod, complete with coil which is ideal for this application; eg. Dick Smith L-0520, Jaycar LF-1015).

By inserting this coil between the aerial and earth, the whole system can be made to resonate at the desired signal frequency by simply sliding the rod in or out of the coil. (At broadcast band frequencies, the aerial itself behaves as a simple capacitor to ground, with a value of around 100pF to 300pF.)

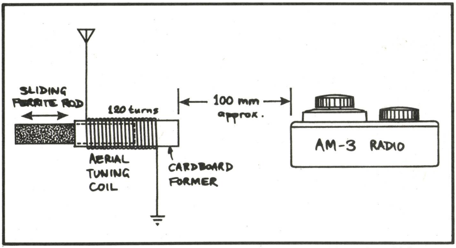
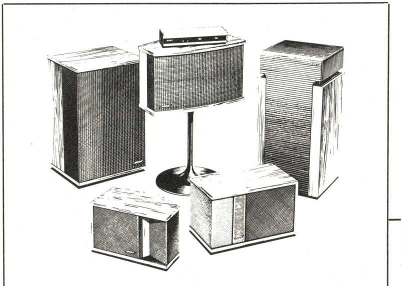


Fig.3: Aerial tuning and "loose" coupling provides ultimate selectivity and sensitivity.

Putting the AM-3 *anywhere near* the tuning coil will give you more signal than the ZN414 can use. A spacing of about 100mm can be used as a starting point (Fig.3). Optimum signal transfer will occur with quite "loose" coupling.

If the coupling is too "tight", the two tuned circuits will interact and form a double-humped response curve, making tuning a frustrating exercise. So start with the coupling loose and simply peak each tuned circuit separately for best reception.

The improvement in reception is quite dramatic: crystal set owners take note!



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Another nail in the analog coffin

Digital Signal Processing

Last month, we looked at the basic theory behind digital signal processing (DSP). This second article considers digital filters, describes how they are designed, and looks at the algorithms used to implement them.

by MIKE FAULKNER
Lecturer at the Footscray Institute of Technology

Filtering is one of the most important and widely used signal processing operations. Digital filters, like analog filters, are used to reject noise, separate signals of different frequencies, modify signal characteristics, and compensate or equalise previous distortions.

Filter characteristics

Filters are normally characterised by their frequency selective behaviour; ie. low-pass, high-pass, bandpass etc. The frequency selective property of a filter, however, is not its only important characteristic. Transient response problems such as risetime limitations and ringing effects can have detrimental effects on some types of input signals (data, for example).

Filter phase response and group delay can also cause problems. Group delay is a measure of the time required for different frequency components to get through the filter. For minimum distortion the group delay for all frequencies within the passband should be the same. This means that frequencies that start out together will arrive at the filter output together, and will not be dispersed in time.

Filters with a constant group delay have a linear phase characteristic; that is, a phase shift that increases linearly with frequency. The terms "linear phase" and "constant group delay" are synonymous. Unfortunately, for many filter classes the group delay is not constant. An illustration is given in Fig.1.

The design of filters is often a compromise between conflicting requirements, with the emphasis being determined by the application. Data signals, for example, require a good group delay and transient response and so selectivity is often sacrificed. Audio signals on the other hand can exploit the ear's low sensitivity to group delay distortion and so highly selective filters with poor phase characteristics can be used. In many hifi applications, tone control circuits and speaker crossover networks still do not have constant group delay.

Even in this day of computer aided design, the filter designer is still required to have a considerable amount of experience. Not only are there specification trade-offs, but there is also a cost and implementation problem.

Normally a designer will choose a certain class of filter ap-

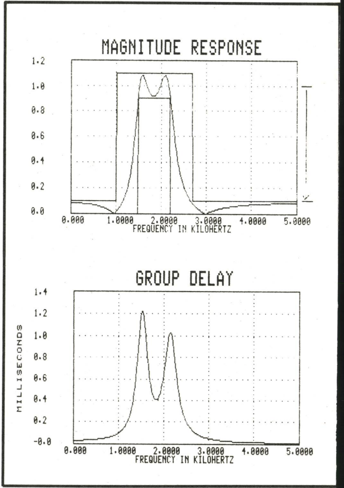

Fig.1: fourth order elliptic bandpass filter. (a) Frequency response The specifications are: passband ripple ±0.1 (1.74dB); stop-band at tenuation 0.1 (20dB); passband cutoff frequencies Fc_1 = 1.5kHz, Fc = 2.2kHz; stop-band frequencies Fa_1 = 1kHz, Fa_h = 2.2kHz. (b Group delay. Frequencies near the passband edges experience th most delay which is a common occurence in filters.

Pt.2

proximation (Butterworth, Chebyshev, etc.) based on group delay, transient response, and implementation considerations, and then design the filter to a frequency specification. The list below shows the necessary specifications for a bandpass filter. These apply to both analog and digital filter design.

(1). Passband ripple: ideal filters have a passband gain of unity. The ripple error is a measure of the tolerance the designer is prepared to accept on this passband gain. Values between 0.1dB and 1.0dB are common. Obviously, the lower the ripple specification the more complex the filter.

(2). Cut-off frequencies (Fc_1 and Fc_h): these define the passband edges.

(3). Stop-band attenuation: the minimum attenuation required throughout the stop-band. The greater this attenuation the more complex the filter. Attenuations between 30dB and 60dB are common.

(4). Stop band frequencies (Fa_1 and Fa_h) — the stop-band edges: the required minimum attenuation must be reached by these frequencies. The narrower the skirts (Fa_h-Fc_h and Fc_1-Fa_1), the more complex the filter.

These specifications are illustrated diagramatically in Fig.1. The designer does not normally care about the actual shape of the filter response provided the specifications are met; ie. the response falls within the set limits.

Digital Filters

The constant coefficient difference equation is the most common algorithm for implementing digital filters. It effectively says that the output is a function of the input, previous inputs and previous outputs.

$$y_n = a_0 x_n + a_1 x_{n-1} + a_2 x_{n-2} + \ldots$$
$$- b_1 y_{n-1} - b_2 y_{n-2} - \ldots\ldots$$

The coefficients a_0, a_1, b_1, b_2, etc determine the filter's characteristic; the current input and output are x_n and y_n, and the previous input and output are x_{n-1} and y_{n-1} etc. Fig.2 shows the implementation block diagram. The blocks marked T represent a delay of one sample period. The z transfer function of this equation is shown below, where Z^{-1} represents a delay of one sample period (T seconds).

$$H(z) = \frac{Y(z)}{X(z)} = \frac{a_0 + a_1 Z^{-1} + a_2 Z^{-2} + \ldots.}{1 + b_1 Z^{-1} + b_2 Z^{-2} + \ldots.}$$

The order of the filter is given by the highest power of Z^{-1} in the expression. The order of the filter is a measure of its complexity and the number of poles it has. The transfer function of a first order filter is shown below. This filter can have a response similar to that of a simple analog RC low-pass network.

$$H(z) = \frac{Y(z)}{X(z)} = \frac{a_0}{1 + b_1 Z^{-1}}$$

Digital filters may be classified as either recursive, having an infinite impulse response (IIR); or non-recursive, having a finite impulse response (FIR). The FIR digital filter is essentially a delay line in which the output is formed by applying various weighting factors to the delayed input signal. The output is not a function of the previous outputs and so all the b coefficients in the previous two equations are put to zero.

Fig.3 shows an example of a three coefficient digital FIR filter. The coefficients, a_0, a_1, etc represent the impulse response of the filter.

Given enough coefficients, FIR filters can implement any amplitude and phase characteristic. Normally, however, they are used to implement linear phase (or constant group delay) filters. Their disadvantage is in the number of coefficients, and hence the processing effort, required to get an acceptable frequency response.

On the other hand IIR filters can be made very selective for a given processing effort (number of multiplications and addi-

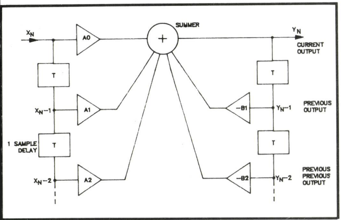

Fig.2: implementation block diagram — direct form. T represents a delay of one sample period.

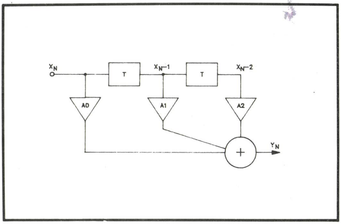

Fig.3: implementation block diagram of an FIR filter with three coefficients.

TEXA TMS32

OVERVIEW

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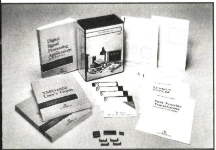

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	ON CHIP		OFF CHIP		ns				DIP	PGA	PLCC		SER	PAR			
	RAM	ROM	PROG	DATA	200	160	125	100	40	68	44	68					
TMS32010	144	1.5K	4K		✓	✓			✓		*✓			8x16	60	NMOS	✓
TMS32011	144	1.5K			✓				✓				2	6x16	60	NMOS	
TMS320C10	144	1.5K	4K		✓	*✓			✓		*✓			8x16	60	CMOS	*✓
TMS32020	544		64K	64K	✓					*✓			1	16x16	109	NMOS	*✓
TMS320C25*	544	4K	64K	64K			✓	✓				✓	1	16x16	133	CMOS	*✓

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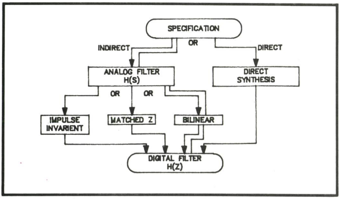


Fig.4: the major design approaches for IIR digital filters. The bilinear transform is used by most commercial CAD packages.

tions.) The rest of this article will concentrate on the IIR type of digital filter.

IIR digital filters

Because these filters include at least one feedback path their impulse response will, theoretically, never completely die away. In this respect, IIR filters are similar to analog filters and in fact the majority of IIR filters are obtained by designing the analog filter first.

The main steps in the design of IIR filters are shown in Fig.4.

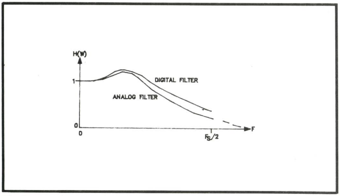


Fig.5: amplitude distortion caused by the impulse invariant transform.

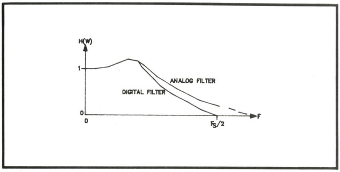
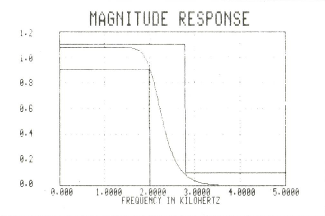


Fig.6: frequency distortion caused by the bilinear transform. This is compensated for by changing (pre-distorting) the original cut-off and stop-band specifications.



Classical Filter Approximations

Many digital filter designs are based on classical analog approximations. In particular, IIR filters are almost wholly based on these approximations. The following table reviews the features of the more important types. Some of these points are illustrated in Fig.7.

- Butterworth
  - flat response in the passband (no ripples)
  - medium selectivity near cut-off
  - attenuation approaches 20dB/decade/pole
  - poor group delay

There are a number of possible approaches. The indirect approach involves designing an analog filter first. This filter is normally one of the classical types; ie. Butterworth, Chebyshev or elliptic, depending on what is appropriate for the application (see Classical Filter Approximations). Analog filters are normally designed from tables which give the pole and zero locations of their transfer function in the s-plane.

There are many transforms for converting an analog filter to a digital filter, three of which are shown in Fig.4. In each case however, the resultant frequency response is distorted, especially in the vicinity of half the sampling rate. The main features of each transform are listed below.

(1) The impulse invariant transform gives the digital filter an identical impulse response to the analog filter. The frequency response of the resulting digital filter has an amplitude distortion which is illustrated in Fig.5. This distortion can be reduced by using sampling rates which are high compared to the cut-off frequency. This transform is not suitable for high-pass filters.

(2) The matched z transform maps the s-plane poles and zeros into the z-plane (see "Z Transforms, Transfer Functions, Poles and Zeros"). This transform has similar limitations to the impulse invariant transform.

(3) The bilinear transform compresses the frequency axis of the analog filter before mapping the s-plane poles and zeros into the z-plane (Fig.6). This overcomes the problems of the above two transforms, but necessitates a modification of the initial cut-off frequency specifications to compensate for the frequency distortion. Although complex, this is the most popular method for designing digital filters and is used by most commercial CAD programs.

Direct design methods obtain the digital filter transfer function directly from the specification. Design equations exist for the mathematically simpler classical filter types such as the Butterworth response, for which a program is included in the section on CAD of Digital Filters .

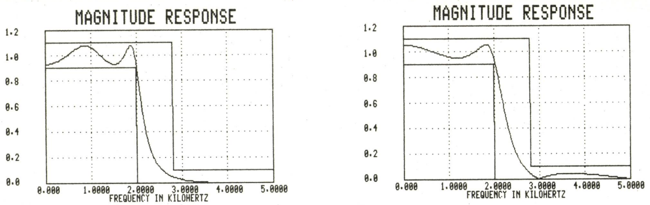


Fig.7: three classical approximations to the same filter specification — (a) 6th order Butterworth, (b) 4th order Chebyshev, (c) 3rd order elliptic.

- Chebyshev
  - equal ripple in the passband
  - high selectivity near cut-off (steep skirt)
  - attenuation approaches 20dB/decade/pole
  - very poor group delay

- Elliptic or Cauer
  - ripples in pass-band and stop-band
  - highest selectivity near cut-off
  - very poor group delay

- Bessel
  - flat response in the passband
  - poor selectivity near cut-off
  - constant group delay

- All-pass
  - flat amplitude, unity gain
  - variable phase or delay (often used to equalise the phase response of other filters).

Implementation of IIR filters

Although the structure shown in Fig.2 can be used to implement IIR filters, it is not normally used. This is because coefficient quantisation effects can cause large changes in the filter characteristics. This problem is reduced by splitting the overall transfer function into a cascade of smaller second order (and perhaps one first order) sections as shown in Fig.9. Each of these smaller sections, often called biquadratic sections, account for two poles and up to two zeros of the overall transfer function.

The implementation structure shown is to be preferred to a second order version of Fig.2. It uses fewer delay elements and therefore less memory. Implementing this section in software first requires the calculation of the variable w_0, then the calculation of the output.

$$w_0 = x - b_1 w_1 - b_2 w_2$$

$$y = a_0 w_0 + a_1 w_1 + a_2 w_2$$

A computer flow diagram for the implementation of a filter with four second order sections is shown in Fig.10, and a listing

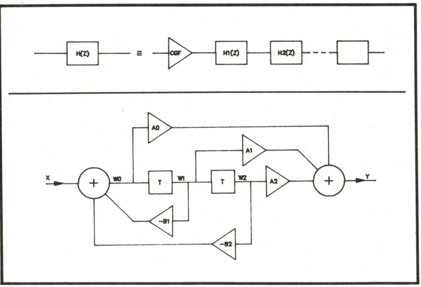


Fig.9: (a) factorising a high order transfer function into second order (with perhaps one first order) biquadratic sections; (b) implementation block diagram of one such section.

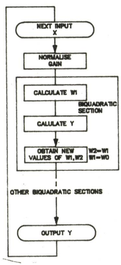


Fig.10: flow diagram — implementing an IIR filter.

of a BASIC program to simulate the response of the filter to a sine wave input is shown in Fig.11. The program is suitable for the IBM-PC and compatibles.

The implementation of the delay block (T) takes some under-

```
10  REM ******PROGRAM TO SIMULATE CASCADED BIQUADRATIC STAGES ******
100 REM READ "NO. OF STAGES","CONSTANT GAIN FACTOR","COEFFICIENTS"
110 READ N,CGF
120 FOR M=1 TO  N
130     READ A0(M),A1(M),A2(M),B1(M),B2(M)
140 NEXT M
200 REM ******RUN FILTER, SIMULATE INPUT******
205 INPUT "ENTER INPUT FREQUENCY WRT SAMPLE FREQUENCY (MAX 0.5)",F
210 FOR J= 1 TO 50
215     X0 = SIN(2*3.14159*J*F)
217     REM EXECUTE ALGORITHM
220     X=X0*CGF
230     FOR M=1 TO  N
240         GOSUB 300
245         X=Y
250     NEXT M
260     REM DISPLAY ON SCREEN
270     PRINT TAB(INT(19*(1+X0)+1.5)) "*" TAB(INT(41.5+19*(1+Y))) "Y"
280 NEXT J
285 PRINT TAB(15) "INPUT SIGNAL" TAB(55) "OUTPUT SIGNAL"
290 END
300 REM ******BIQUADRATIC SECTION******
310 W0(M) = X - B1(M)*W1(M) - B2(M)*W2(M)
320 Y = A0(M)*W0(M) + A1(M)*W1(M) + A2(M)*W2(M)
330 W2(M) = W1(M)
340 W1(M) = W0(M)
350 RETURN
1000 DATA 4,.0000001762
1010 DATA 1,2,1,-1.794,0.8863
1020 DATA 1,2,1,-1.623,0.7069
1030 DATA 1,2,1,-1.513,0.5912
1040 DATA 1,2,1,-1.460,0.5348

RUN

ENTER INPUT FREQUENCY WRT SAMPLE FREQUENCY (MAX 0.5)? .06

    *                                               Y
          *                                         Y
                 *                                  Y
                        *                             Y
                              *                        Y
                                   *                      Y
                                      *                     Y
                                      *                       Y
                                   *                            Y
                              *                                  Y
                        *                                        Y
                 *                                               Y
          *                                                     Y
    *                                                         Y
 *                                                          Y
*                                                         Y
  *                                                     Y
      *                                                Y
            *                                         Y
                   *                                  Y
              INPUT SIGNAL                            OUTPUT SIGNAL
```

Fig.11: IIR filter simulation program. Input data format is 1000 DATA (no. of biquad. sections), (CGF) 1010 DATA (a_0), (a_1), (a_2), (b_1), (b_2) etc.

Computer Aided Design (CAD) of Digital Filters

Just as VLSI has helped in the implementation of DSP algorithms (to the point where they are serious contenders for signal processing systems handling frequencies up to 20kHz), so has the advent of CAD reduced the design effort in deriving the algorithms in the first place.

For example, programs now exist which can design digital filters and then automatically write the assembly code for their implementation on a DSP microprocessor. Any serious DSP designer should have access to one of these packages. The potential saving in design time is immense. To give an example, the first digital filter designed by the author took three days (before CAD packages were generally available); the same filter designed on one of these packages would probably take 30 minutes.

Unfortunately, these packages are expensive so a small BASIC program is included here for those readers wishing to design their own filters (Fig.8). The program is limited to low-pass even order Butterworth designs. The program will generate coefficients for the second order biquadratic sections, and a constant gain factor (CGF) which is necessary to normalise the DC gain of the filter to unity.

The same program can be used to obtain a high-pass response with the aid of a low-pass to high-pass transformation. In this case, replacing Z^{-1} with $-Z^{-1}$ in the transfer function (by inverting the sign of the a_1 and b_1 coefficients in each biquadratic section) changes a low-pass filter with a 3dB cut-off frequency of Fc to a high-pass filter with a 3dB cut-off frequency of (Fs/2-Fc). Transforms for bandpass and band-stop also exist (see T.J. Terrell, "Introduction to Digital Filters", Macmillan 1980).

```
10 REM   CALCULATION OF BUTTERWORTH LP BIQUADRATIC SECTIONS
20 INPUT "FILTER ORDER (MUST BE EVEN)";N
30 INPUT "SAMPLE FREQUENCY HZ";S
40 INPUT "3DB CUT-OFF FREQUENCY HZ";C
50 F=C/S: PI =3.141593: A = TAN(PI*F): CGF = 1
60 PRINT "A0","A1","A2","B1","B2"
70 FOR M=0 TO (N/2-1)
80       T = (2*M + N + 1)*PI/(2*N)
90       D = (1 - 2*A*COS(T) + A^2)
100      U = (1-A^2)/D:V = 2*A*SIN(T)/D
110      CGF = CGF*(1-2*U+U^2+V^2)/4
120      PRINT 1,2,1,(-2*U),(V^2+U^2)
130 NEXT M
140 PRINT "CONSTANT GAIN FACTOR = ",CGF
150 END


RUN
FILTER ORDER (MUST BE EVEN)? 8
SAMPLE FREQUENCY HZ? 10000
3DB CUT-OFF FREQUENCY HZ? 500
A0            A1            A2            B1            B2
 1             2             1            -1.793962      .8862831
 1             2             1            -1.623406      .7069499
 1             2             1            -1.513291      .5911681
 1             2             1            -1.459706      .5348261
CONSTANT GAIN FACTOR =       1.762551E-07
```

Fig.8: Basic listing of a program to design even order low-pass Butterworth filters. The input requirements are the sample frequency 3dB cut-off frequency, and the filter order. The output gives the biquadratic coefficients and the constant gain factor (CGF).

TEXAS INSTRUMENTS

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Simply explain in less than 500 words why you deserve to win this Digital Signal Processing (DSP) Development System.

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Send your entry to

The Editor,
Electronics Australia,
PO Box 227,
Waterloo 2017

The winner will be notified by mail and the result announced in the March 1987 issue of Electronics Australia.

standing. In this case, T is the time required for one complete program pass through the loop. In that time, data in variable w_0 becomes the previous data, in which case it is stored in w_1. Line 340 of the program implements the first delay block, and line 330 the second.

That's all we have space for this month. In the final article, we will consider FIR filters and DSP implementation.

Footnote: in the box headed "The Discrete Fourier Transform (DFT)" on page 94 of last month's issue, reference is made in the second paragraph to equation (4). This should have read equation (3).

Z Transforms, Transfer Functions, Poles and Zeros

Using suitable CAD packages it is possible to design digital filters with little or no knowledge of z transforms. This section, therefore, is for readers interested in a better understanding of DSP theory.

The transfer function relates the output of a linear system to its input. Unfortunately, the transfer function only applies to transformed signals. The Laplace transform is used for analog signals, while the z transform is used for digital signals. In the digital case the transfer function H(z) is the z transform of the impulse response hn

$$H(z) = \sum_{n=-\infty}^{+\infty} h_n z^{-n}$$

and the output Y(z) is related to the input X(z) by

$$Y(z) = H(z)\,X(z)$$

The above equations effectively say that the operator, z^{-1}, represents a delay of one sample period (T). For example, the transfer function H(z) of the DSP system with impulse response hn = {0.5. 1.0, 0.5} is

$$H(z) = 0.5 + 1.0\,z^{-1} + 0.5\,z^{-2}$$

Analysis of the transfer function can give some valuable insights into the behaviour of the network. In particular, the value of the poles and zeros of the expression can be used to determine the system's stability and frequency response.

Poles are the value of z that cause the expression H(z) to go to infinity, and zeros are the values of z that cause the expression to go to zero. In the above expression two poles are located at z = 0, and two zeros at z = -1.

It is normal to plot the positions of the poles and zeros on a diagram called a z-plane (or s-plane for analog systems). Since poles and zeros can have real and imaginary components, the plane has a real and imaginary axis as shown in Fig.12. Stability is guaranteed if all transfer function poles lie within a circle of radius one from the origin. Zeros have no effect on stability.

The s- and z- planes are related through the unit delay T because the Laplace transform of a fixed delay of T seconds is equal to e^{-ST} and the z transform is equal to z^{-1} and so

$$z^{-1} = e^{-sT} = e^{-(\sigma + jw)T}$$

This equation relates any point in the s-plane to a point in the z-plane. Using this expression the stable left hand region of the s-plane maps into a circle of radius 1 (unity).

One of the techniques for designing digital filters is to first obtain the pole and zero positions of the necessary analog filter, and then transfer them into the z-plane by using the above relationship (matched z transform); the digital transfer function H(z) can then be obtained.

If, for example, we take the analog RC network of Fig.13, it has an analog pole at s = -1/RC and a zero at negative infinity. These map into a pole on the z-plane at $z = e^{-T/RC}$ and a zero at the origin. The transfer function is therefore:

$$H(z) = \frac{Y(z)}{X(z)} = \frac{z - 0}{z - e^{-T/RC}} = \frac{1}{1 - e^{-T/RC}\,z^{-1}}$$

(Note: the DC gain of this function can be obtained by putting z equal to 1). This transfer function can easily be converted into a DSP algorithm by remembering that z^{-1} represents a delay of one sample period (T), or

$$y_n = x_n + e^{-T/RC}\,y_{n-1}$$

Substituting values for R and C, choosing a sample period T = 0.1ms (Fs = 10kHz), and then compensating for the DC gain produces the algorithm

$$y_n = 0.01\,x_n + 0.99\,y_{n-1}$$

where 0.01 provides the gain normalisation.

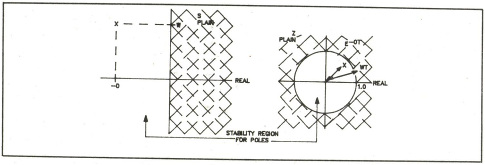


Fig.12: mapping s-plane poles (zeros) into the z-plane. Z-plane poles outside the unit circle cause instability.

Interpretation of DSP Signals

When testing digital filters using a cathode ray oscilloscope (CRO) it is often difficult to interpret the results. This is because an accurately repeating sweep requires the synchronisation of three independent generators, these being the CRO timebase, the input signal and the DSP sampling rate. The trigger facility on the CRO can only synchronise to one other signal.

The other problem is illustrated in Fig.14 In all cases, the top trace is the analog input signal and the bottom trace the sample data output from the DSP.

Observers of the top photo could be tricked into thinking that their DSP algorithm was not working, the output appearing to be totally unrelated to the input signal. The individual steps, however, can be seen distinctly. This is because the CRO is triggering off the bottom trace.

Changing the trigger to the top (input) trace and then expanding the timebase gives the second photo. The relationship between the input and output can now be seen. The blur on the output trace is caused by the changing position of the output steps for each sweep of the trace. The horizontal width of the blur is equal to the output step size; ie. the sample period.

These effects are especially prevalent when the input signal frequency is close to half the sampling rate (Fs/2). Special care must be taken, therefore, when testing high-pass filters.

The last photograph shows the best of both worlds. However, this was obtained using a single sweep of the CRO. The sweep of the trace is normally too fast for the eye to follow, and a storage facility or camera is necessary.

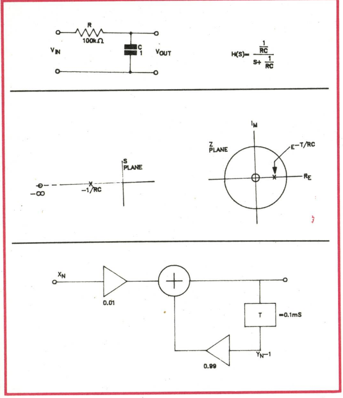


Fig.13: Designing a first order IIR filter to emulate an RC network — (a) RC network and transfer function; (b) Converting the poles and zeros to the z-plane; (c) Implementation block diagram.

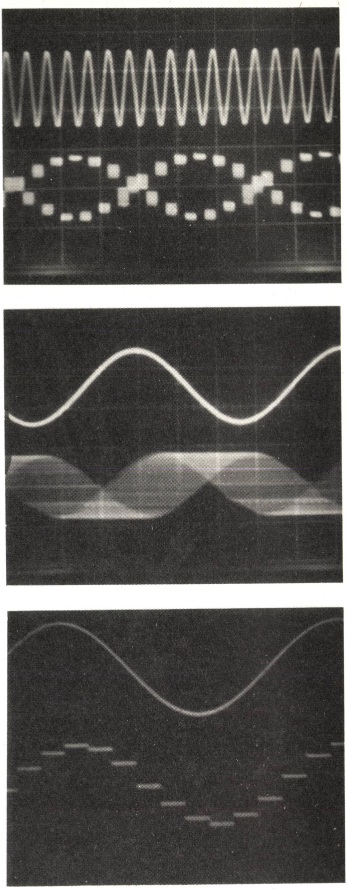
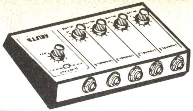


Fig.14: CRO traces showing a DSP output from the D/A converter — (a) Triggering off the output (bottom trace); (b) Triggering off the input (top trace); (c) Single sweep.

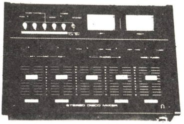


ECONOMY 4 CHANNEL MICROPHONE MIXER (MM1)

Its size and simplicity makes this mixer very portable and easy to operate.

SPECIFICATIONS:
- 4 low impedance 600 ohm microphone inputs.
- Individual gain control for each microphone.
- Master volume control.
- Power on LED.
- Inputs/Outputs - 6.3mm mono sockets.
- DC operated (9V battery only).
- Input impedance 600 ohm.
- Output impedance 1.5kohm.
- Signal/noise ratio 55dB.
- Frequency response 20Hz to 20kHz plus or minus 2dB.
- Weight 320 grams.
- Dimension 148 x 46 x 86mm.
- Torque variable range 1-22dB.
- Input sensitivity 1mV.
- Output level 90mV (at input 5mV).
- T.H.D. 0.01%.

Cat. A12001 .... **$44.95**

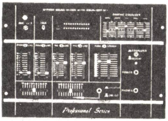


UNIVERSAL MIXER WITH CUE CONTROL (MM3)

- Microphone inputs 2 high or low impedance.
- Two stereo phono inputs magnetic or ceramic.
- 1 stereo line input for tape or tuner.
- Cue function with LED indicator for each input.
- Tape recorder output connections.
- Dual VU meters to monitor output and cue level.
- Mono/stereo mode selector.
- Battery test button to check their condition.
- DC or AC adaptor operation.

Input Sensitivity: Mic. low 0.7mV at 600 Ohm,Mic High 3.5mV at 50k ohm
Phono Mag. 2.5mV at 50k ohm, Phono Cer. 150mV at 100k Ohms
Tape Tuner: 150mV 50k ohms
S/N Ratio: More than 55dB
T.H.D.: Less than 0.5%
Frequency Response: 20 - 20kHz +−2dB
Output Level: 300mV
Recording Output: 120mV
Power Source: 9V DC (PP100/9)
Dimensions: 265 x 195 x 70mm
Weight: 1.8kg

RRP **$199** .... **OUR PRICE $179**



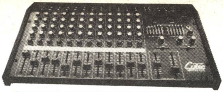
UNIVERSAL STEREO MIXER WITH GRAPHIC EQUALISER (MM4)

The MM4 is our most flexible mixer. Incorporating the most advanced IC technology for performance and reliability. Built in graphic equaliser virtually eliminates the need for a pre-amplifier. Features 4 stereo program and 2 microphone inputs.

SPECIFICATIONS:
Input Sensitivity:
  Mic. 1.5mV at 10k ohm
  Phono. 1.5mV at 50k ohm
  Line 75mV at 50k ohm
Rated Output:
  Amp 1V/600 ohms
  Rec. 1V/600 ohms
T.H.D.: Less tham 1% at 1kHz
Hum and Noise:
  Mic. -52dB
  Phono -62dB
  Line -65dB
Frequency Response:
  Mic. 30 - 16kHz (-1dB)
  Phono 30 - 20kHz (RIAA+−dB)
  Line 20 - 30kHz (-1dB)
Power Source: 240V AC 50Hz
Size: 360 x 260 x 85mm
Weight: 2.9kg

EQUALISER SECTION
Control of Frequency: 60Hz, 250Hz, 1kHz, 3.5kHz, 12kHz
Control Range: +−12dB boost or cut - centre detent
Headphone Output: (Cue)50mW at 75 ohm at 0.5% T.H.D.
Talk Switch: -14dB

R.R.P. $399 .... **OUR PRICE $379**



12 CHANNEL STEREO MIXING CONSOLE (MX1210)

Loaded with professional features but simple to operate. A 3 position attenuation switch with −15dB, 0dB, +15dB, together with separate mic. and line inputs allows perfect matching with any input signal. Foldback with the pre-fade send or on stage monitoring. Includes bass and treble controls plus a left and right 5 band graphic equaliser. Other features include effect return panning, P.P.I. overload indicators and stereo headphone monitoring. Ideal for disco's with 2 stereo disc inputs with cross fade. A high quality 12 channel mixer for the professional enthusiast.

SPECIFICATIONS
Inputs:
  12 x Mic −46dB at 47k ohm
  12 x Line −20dB at 20k ohm
  12 x Phono −52dB at 50k ohms (approx 2mV at 1kHz)
  Effect Return −20dB at 50k ohm
Ouputs:
  PGM Out 0dB at 10k
  F/B Out 0dB at 10k ohm
  Effect Send 0dB at 10k ohm
  Rec. Out −4dB at 10k ohm
  Headphones +10dB at 600 ohm (100 - 1k ohm)
Equaliser (Channel): Bass+−12dB(100Hz), Treble+−12dB(10kHz)
Equaliser (Master): 100/330/1k/3.3k/10kHz, (5 band stereo)+−12dB
Frequency Response: 20 - 20kHz (+1dB, −3dB)
S/N Ratio (IHF-A): 120dB
T.H.D.: 0.15% at 1kHz
Peak Indicators: 12 x LED
Power Supply: 240V AC 50Hz
Power Consumption: 8W
Dimensions: 662(W) x 356(D) x 105(H)mm
Weight: 8kg

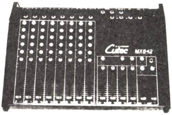
RRP $1,256 .... **OUR PRICE $1,150**

16 CHANNEL STEREO MIXING CONSOLE (MX1610)

The same general description as the MX1210 but with the advantage of more channels.

SPECIFICATIONS
Inputs:
  16 x Mic −46dB at 47k ohm
  16 x Line −20dB at 20k ohm
  16 x Phono −52dB at 50k ohm(approx 2mV at 1 kHz)
  Effects Return −20dB at 50k ohm
Outputs:
  PGM Out 0dB at 10k
  F/B Out 0dB at 10k ohm
  Effect Sound 0dB at 10k ohm
  Rec. Out −4dB at 10k ohm
  Headphones +10dB at 600 ohm (100 - 1k ohm)
Equaliser (Channel): Bass+−12dB(100Hz), Treble +−12dB(10kHz)
Equaliser (Master): 100/330/1k/3.3k/10kHz, (5 band stereo) +−12dB
Frequency Response: 20 - 20kHz (+1dB, −3dB)
S/N Ratio (IHF-A): 120dB
T.H.D.: 0.15% at 1kHz
Peak Indicators: 16 x LED
Power Supply: AC117/220/240V, 50/60Hz
Power Consumption: 8W
Dimensions: 750(W) x 356(D) x 105(H)mm
Weight: 9kg

RRP $2,330 .... **OUR PRICE $2,095**



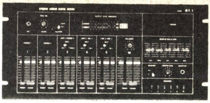
MULTITRACK MIXING CONSOLE (MX842)

With balanced and Cannon inputs the MX842 is a complete multitrack mixing console. The four group out with stereo master configuration is designed for both studio and P.A. applications, either with a four track recorder or live P.A. mixing with the advantage of four sub groups. It is well equiped with all functions needed to produce first class results.

FEATURES:
- Balanced line inputs
- Cannon and 6.35mm inputs
- 240V operated, fuse protected
- Comprehensive headphone monitoring

Inputs:
  8 x Mic: −46dB/18k ohm (Cannon)
  8 x Line: −20dB/15k ohm (6.35)
Outputs:
  2 x Master: Max. output +18dBV (Cannon)
  4 x Group: Max. output +18dBV (6.35mm)
  1 x Master Effect Send: Gain 18dBV (6.35mm)
  2 x Record: Gain 18dBV (6.35mm)
  1 x Headphone Output: 2mW-8kohm, 30mW at 500ohms
Frequency Response: 20-20kHz +−2dB
S/N Ratio: 120dB
T.H.D.: Less than 0.15% at 1kHz
Peak Indicators: 5 point master level control
Power Consumption: 15W
Power Supply: 240V AC 50Hz
Dimensions: 622(W) x 105(H) x 356(D)mm
Weight: 6.8kgs

R.R.P. $1,425 .... **OUR PRICE $1,275**



DISCO MIXER WITH GRAPHIC EQUALISER (MX1)

This stereo mixer is especially designed for discotheques and radio studios. It is a versatile rack or console mounting mixer with varied features which enable high quality broadcasts through its 3 microphone inputs, 3 phono inputs or 3 line inputs.

- 6 channel monitoring system
- 9 point dual LED output level display
- Output panpot
- 3 outputs
- Adjustable talkover with LED display
- Master level control

SPECIFICATIONS
Input:
  Talk Mic. 47k ohms nominal 5mV
  Mic. 2,3 47k ohms nominal 5mV
  Phono 1,2,3 47k ohms nominal 5mV
  Line 1,2,3 37k ohms nominal 300mV
  Output 1k ohm nominal 0.775V
  Rec. Out 1k ohm nominal 250mV
  Line Out 1k ohm nominal 250mV
Frequency Response:
  Talk Mic. 150Hz - 7kHz −3dB
  Mic. 2,3 15Hz - 30kHz −3dB
  Phono 1,2,3 20Hz - 20kHz +−2dB
  Line 1,2,3 15Hz - 100kHz −3dB
S/N Ratio: (IHF-A,input short)
  Talk Mic. −73dB/5mV
  Mic. 2,3 −73dB/5mV
  Phono 1,2,3 −76dB/5mV
  Line 1,2,3 −80dB/300mV
Crosstalk: Better than 60dB/1kHz
T.H.D.: Less than 0.1%/1kHz
H.P. Out Level: 55mW/80 ohms - 1k ohm
Eq. Frequency: 60/250/1k/4k/12kHz+−12dB
Talk Over Level: −14dB
Meter Level: 0dB=0.775V/1.5V
Power Consumption: 15 watts
Power Supply: 240V 50Hz
Dimensions: 482(W)x222(H)x130(D)mm
Net Weight: 4.5kg

R.R.P. $865 .... **OUR PRICE $765**

WIRELESS MICROPHONE RECEIVER WA100

Made by Piezo (Azden) of Japan, this device will turn any microphone fitted with a Cannon Type male socket into a wireless microphone. The receiver will plug into any 6.35mm microphone input. Both transmitter and receiver can be tuned from 76 - 81MHz.

Freq. Response: 50 - 16kHz
Tunable: 76 - 81MHz
Field Strength:
  Transmitter 10uV/100 metres
  Receiver 15mV (100%)
Battery: Transmitter LR44 (1.5V)
  Receiver 3 x UM4 (4.5V)
Instructions: Japanese (English not available!)

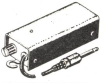
Cat. A10520 .... **R.R.P. $199**
Our price, only $189

ARLEC "DISCO LITE" CONTROLLER

Give your parties a professional touch with the arlec "Disco Lite". Simply plug your light(s) into the "Disco Lite" and you've instant party life!

3 DIFFERENT MODES!
Music Mode: Place the "Disco Lite" in range of the speakers and it flashes the lights to the beat of the music!
Strobe Mode: Simply adjust to desired speed! Great for mime or theatre! The christmas season or advertising!
Dim Mode: Allows you to dim the lights to create moods, effects etc.

Cat. M22003 **$49.50**



MICROPHONE ECHO ADAPTER (SM100)

Gives microphones "depth". Invaluable when using them in "dead" room/halls etc.

- Echo effects may be varied
- Volume control
- Power on LED
- Fits in line
- Standard 6.5mm socket and plug
- Power 9V battery
- Input low impedance
- Output 30mV (max)
- Signal/noise ratio 40dB
- Delay time up to 60m seconds
- Frequency response 50 - 15kHz
- Cord length 75cms
- Weight 220 grams
- Dimensions 115 x 32 x 44mm

Cat. A10530 .... **$44.95**

CRYSTAL LOCKED WIRELESS MICROPHONE

MICROPHONE SPECIFICATIONS:
Transmitting Frequency: 37.1MHz
Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

RECIEVER SPECIFICATIONS:
Recieving Freq: 37.1MHz
Output Level: 30mV (maximum)
Recieving System: Super heterodyne crystal oscillation.
Power Supply: 9V Battery or 9V DC power adapter.
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
Weight: 220 grams

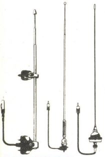
Cat. A10452 .... **R.R.P. $113**
Our price, $99

Audio Audio Audio Audio Audio

CAR REPLACEMENT SPEAKERS

All are rated at 4 ohm, Nominal 3W, Maximum 5W with 3 inch magnets, and feature dust proof covers.

5" x 7" Oval	Cat.C10757	**$11.95**
4" x 6" Oval	Cat.C10746	**$10.50**
5" Round	Cat.C10705	**$8.95**
6" Round	Cat.C10706	**$10.95**



CAR ANTENNAS

- 4 section
- 860mm length
- Top key lock down
- 1.2 metre lead

Cat. A12061 .... **$5.95**

MODEL CA-2

- 3 section
- 1.4 metres extended
- 1.2 metre lead
- Spring based

Cat. A12062 .... **$13.95**

MODEL CA-3

- Stainless
- Top cowl
- 1 section whip
- 1 metre length
- 1.2 metre lead

Cat. A12063 .... **$7.95**

MODEL CA-4

- Pillar mount
- 3 section
- Suits Toyota, Nissan, Mazda

Cat. A12060 .... **$6.95**

MODEL CA-5

- Roof, boot, mount anywhere
- 830mm length
- 3 section, tuned for FM
- 2 metre lead

Cat. A12065 .... **$12.95**

MODEL CA-6

- Rubber duckie
- 1 section flexible rubber
- Flexible spring base
- Adjustable ball
- 1.2 metre lead

Cat. A12066 .... **$11.95**

MODEL CA-7

- Black, 1 section whip
- Top cowl
- 1 metre length
- 1.2 metre lead

Cat. A12067 .... **$7.95**

CAR ANTENNAS (POWERED)

MODEL ACA-1

- Semi automatic
- 5 section
- 1 metre stainless steel
- 1.2 metre feeder cable
- 12V DC

Cat. A12070 .... **$34.95**

MODEL ACA-2

- Fully automatic
- 5 section
- 1 metre stainless steel
- 1.2 metre feeder cable
- 12V DC

Cat. A12071 .... **$49.95**

MODEL ACA-3

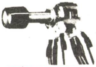
- Semi automatic, flush head
- 5 section
- 1 metre stainless steel
- 1.2 metre feeder cable
- 12V DC

Cat. A12072 .... **$59.95**

CAR ANTENNA BOOSTER

- In-line instalation
- 12V boosts 100%

Cat. A12073 .... **$7.95**



STEREO VOLUME CONTROL

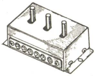
30W RMS, wire wound, ceramic base with heatsink

Cat. A **$29.95**

STEREO VOLUME CONTROL

10W RMS, wire wound, ceramic base with heatsink

Cat. A **$29.95**



SPEAKER SELECTION SWITCH

- Allows on/off selection of 3 sets of stereo speakers.
- All input/output connections with screw terminals
- Input 8-16 ohms
- Output 8 ohms

Cat. A16050 .... **$14.50**

POWER/SPEAKER SWITCH

Selects power and speakers between radio and cassette player (2 speakers)

Cat. A **$4.95**

POWER/SPEAKER SWITCH

Selects power and speakers between radio and cassette player (4 speakers)

Cat. A **$8.95**

STEREO FADER CONTROL

Allows front/rear control. 30W RMS, ceramic base with heatsink

Cat. A **$25.95**

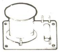
ELECTRONIC RHYTHM BOX

- 8 selectable rhythms, Trot, Rock Disco, Bossanova, Waltz, Slow Rock, Cha Cha, Rumba
- Power 9V battery or AC adaptor
- Volume control
- Rhythm tempo control, 10 steps
- Power on LED
- Footswitch facilities
- Output level 150mV (max)
- Weight 750 grams
- Dimensions 190 x 52 x 132mm

Cat. A12048 .... **$89.95**

CROSSOVER NETWORKS

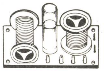
Crossovers are essential for multiway speaker systems, otherwise your bass will be degraded by intermodulation distortion and cone break up, and your treble will be distorted by bass components. These crossovers are designed to channel only the frequencies that each driver can properly handle. Read the specifications to choose the correct one for your need.



2 WAY 60 WATT CROSSOVER NETWORK

- 6dB attenuation
- Cross over point 3,500 Hz
- Impedance 8 ohms

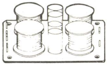
Cat. A16001 .... **$7.95**



3 WAY 60 WATT CROSSOVER NETWORK

- 6dB attenuation
- Cross over point 800 and 5,000 Hz
- Impedance 8 ohms

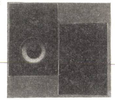
Cat. A16003 .... **$12.95**



3 WAY 100 WATT CROSSOVER NETWORK

- 12dB attenuation
- Cross over point 800 and 5,000 Hz
- Impedance 8 ohms

Cat. A16005 .... **$28.95**

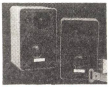


2 WAY MID SIZED SPEAKER SYSTEM

Labyrinth enclosure assures adequate bass at low volume. Polypropolene woofer with aluminium voice coil. Finished in walnut cabinet with removeable black grille.

SPECIFICATIONS:
Speakers: 6$\frac{1}{2}$" woofer and 2$\frac{1}{2}$" tweeter.
Power input: 30W RMS 86dB/Wm
Impedance: 8 ohms
Frequency Response: 60 - 20kHz
Size: 345(H) x 230(W) x 280(D)mm
Weight: 3.8kg each

Cat. C10766 .... **$179**



3 WAY MINI BOOKSHELF SPEAKER SYSTEM

Aluminium diecast cabinet. Superb sound for it's size with polypropolene cone for bass driver. Finished in silver/grey with black mesh grille and comes complete with mounting bracket.

SPECIFICATIONS:
Speakers: 4$\frac{1}{2}$" woofer. 2" midrange. 1" dome tweeter.
Power input: 30W RMS 86dB/Wm
Impedance: 8 ohms
Frequency Response: 70 - 20kHz
Size: 186(H) x 116(W) x 120(D)mm
Weight: 2kg each

Cat. C10764 .... **$169**

1" DOME TWEETER SPEAKER

Mylar diaphragm
SPECIFICATIONS:
Sensitivity: 96dB
Frequency Response: 2-20 kHz
Impedance: 8 ohms
Power RMS: 15 watts RMS
Magnet Weight: 5.4cz.
Size: 96mm diameter

Cat. C10234 .... **$10.95**

2" HORN TWEETER SPEAKER

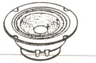
Mylar diaphragm, aluminium voice coil
SPECIFICATIONS:
Sensitivity: 95dB
Frequency Response: 1.5-20 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 2.5oz.

Cat. C10232 .... **$8.95**

4" EXTENDED RANGE SPEAKER

Rubber edge, black cone
SPECIFICATIONS:
Sensitivity: 90dB
Frequency Response: 90-8 kHz
Impedance: 8 ohms
Power RMS: 8 watts RMS
Magnet Weight: 5.3oz.

Cat. C10220 .... **$13.95**



5" MIDRANGE SPEAKER

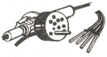
Sealed back, foam edge, black cone, silver dust cap.
SPECIFICATIONS:
Sensitivity: 98dB
Frequency Response: 500-8 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 5.4oz.

Cat. C10230 .... **$12.95**

6½" TWIN CONE FULL RANGE SPEAKER

Foam edge, black cone, black whizzer cone
SPECIFICATIONS:
Sensitivity: 89dB
Frequency Response: 60-15 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 5.3oz.

Cat. C10222 .... **$14.95**



UNIVERSAL CAR RADIO/CASSETTE LEAD

Connects stereo unit to battery, speakers switch. Universal plug fits most stereo units. Fuse carrier in red lead with 3A fuse.

Cat. A12052 .... **$2.95**

8" TWIN CONE FULL RANGE SPEAKER

Foam edge, black cone, black whizzer cone
SPECIFICATIONS:
Sensitivity: 98dB
Frequency Response: 45-16 kHz
Impedance: 8 ohms
Power RMS: 30 watts RMS
Magnet Weight: 13oz.

Cat. C10224 .... **$23.95**

8" WOOFER HIGH POWER SPEAKER

Cloth edge, dark grey cone, rubber mounting seal, cloth dust cap.
SPECIFICATIONS:
Sensitivity: 90dB
Frequency Response: 60-4 kHz
Impedance: 8 ohms
Power RMS: 50 watts RMS
Magnet Weight: 20oz.

Cat. C10226 .... **$34.95**

10" WOOFER HIGH POWER SPEAKER

Cloth edge, dark grey cone, rubber mounting seal, cloth dust cap.
SPECIFICATIONS:
Sensitivity: 93dB
Frequency Response: 50-2.5 kHz
Impedance: 8 ohms
Power RMS: 100 watts RMS
Magnet Weight: 30oz.

Cat. C10228 .... **$59.95**

12" WOOFER HIGH POWER SPEAKER

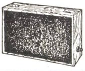
Cloth edge, dark grey cone, rubber mounting seal, cloth dust cap.
SPECIFICATIONS:
Sensitivity: 97dB
Frequency Response: 28-4 kHz
Impedance: 8 ohms
Power RMS: 50 watts RMS
Magnet Weight: 30oz.

Cat. C10229 .... **$69.95**

DUAL ATTENUATOR

- LED indicator
- Mid/High range for 3 way systems
- Impedance 8-10 ohms
- Power handling 18 watts RMS

Cat. A16013 .... **$17.95**



EXTENSION SPEAKER 1

Slimline walnut cabinet with mounting holes and volume control.
SPECIFICATIONS:
Speaker: 5"
Impedance: 8 ohm
Magnet: 3oz
Nominal Power: 3W/5W maximum
Size: 245(L) x 150(W) x 65(D)mm

Cat. C????? **$44.95**

PORTABLE MINI P.A. AMPLIFIER

A completely portable system, sets up anywhere in seconds. Inputs for microphone, electronic organ and cassette players. Variable echo makes this an ideal unit for buskers and budding singers.
SPECIFICATIONS:
Output power: 1W RMS, 2W max.
Frequency Response: 100-15kHz
Speaker: 5" full range, 4 ohms
Echo Time: Variable 5-52m/sec
Power Source: 6 x "D" size batteries (position for power adaptor also)
Size: 280(H) x 120(W) x 180(D)mm
Weight: 1.3kg

Cat. A12022 .... **$89.95**

MINI HAND HELD MEGAPHONE

Suitable for schools, sports meetings, boats, etc. Portable, lightweight and effective with anti howling dynamic microphone. High power output, low power consumption.
SPECIFICATIONS:
Size: 150mm diameter
Power output: 2/4 watt maximum
Effective Distance: 120 metres
Power source: 6 x "AA" batteries
Power duration: 6 hours
Weight: 0.6kg.

Cat. A ????? **$69.95**

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For text and graphics with colour . . .

Epson's EX-800 dot matrix printer

There's no doubt about it. Printers are continuing to become more intelligent, easier to use and above all, faster. It used to be that dot matrix printers were used only where print quality was unimportant. Now they are displacing daisy-wheel printers because they can produce good quality print and graphics output too. And the Epson EX800 can also print in colour.

by LEO SIMPSON

NLQ is a term you see more often these days when reading the specs of dot matrix printers. The term stands for "near letter quality" and it means just below the print quality of a daisy-wheel printer or golf ball typewriter.

Some dot matrix printers produce near letter quality by employing a large number of pins in their print head. Instead of using the standard seven, eight or nine pins, some print heads have 24 pins. As they move across the paper these very fine pattern print heads have no difficulty in producing a dot matrix pattern which is almost equivalent to a good daisywheel machine.

The EX800 attacks the problem in a different way. It only has nine pins in its print head but it produces a fine quality print by passing its print head across the paper twice and moving the paper slightly in between, so each line of print requires two passes of the print head when in NLQ mode. In draft mode, only one pass is used and the dot matrix structure of the printed words is clearly evident. What this means is that the machine is much faster in draf mode than in NLQ mode. Is that the end of the story? No, not by a long shot.

Where the dot matrix NLQ printer has it all over the daisy-wheel printer is that it can easily change print fonts With a daisy-wheel printer the only way to change fonts is to change prin wheels, a process which can be fiddly and requires stopping the printer. With an NLQ dot matrix printer on the other hand, you have the possibility of changing print fonts in mid-sentence, under software control.

For some years now, most dot matrix printers have offered this feature whether they had pretensions to "letter quality" or not. The way in which the instructions were delivered to the printer was by ESC instructions embed-

The Epson EX-800 dot matrix printer for text and graphics is flexible and fast.

ded into the text or material to be printed.

Now this is all very well if you are printing out a file under Basic or DOS and it consists of ASCII characters. But if you are using a word processing program such as Wordstar, things are not so simple. The ESC sequences don't work unless they are "patched" into the program. And since you can have only a limited number of patches in Wordstar, the number of different print options you can actually use are limited.

With the EX-800 though, you have another way of changing fonts within the one piece of text. You can merely take the printer off-line at any stage during printing, select the desired font and then continue printing. Epson refer to this feature as SelecType and it gives three basic fonts: Draft (which is fast and looks like dot matrix printout), Roman and Sans Serif (which means without the serif, the curly bits on typefaces).

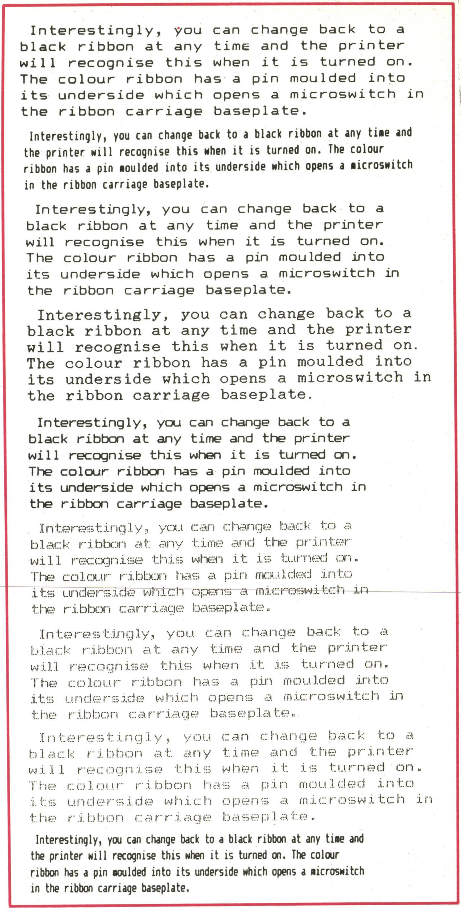
At the same time, you can also select the print width; Pica (10 characters per inch); Elite (12 characters per inch); Proportional which is fairly close to Pica but varies the amount of space depending on each character; and Condensed (about 60% compression) for all three of these modes. If you select both Elite and Condensed you can get up to 160 characters per line which is handy if you want to print out large spreadsheets. Normally this could not be done on a printer of this sort because the maximum paper width is 80 columns (when in the Pica mode).

I should mention that some word processing programs will not let you change fonts using the SelecType feature because they initialise the printer to selected fonts at the start of printing which will effectively cancel some typestyles. There are ways around that though, by re-customising your program to take this into account.

Naturally, you can use subscripts, superscripts, emphasised and double-strike modes and italics. The EX-800 supports the full ASCII set, including Greek symbols. It can also emulate IBM printers and thus give their full graphics character set or, in its own Epson mode, give eight international character sets: USA, English, French, German, Danish, Swedish, Italian and Spanish. These features are selectable by means of two eight-way DIP switches at the rear of the machine.

Graphics

And as with most dot-matrix printers these days, the EX-800 will support dot-



Interestingly, you can change back to a black ribbon at any time and the printer will recognise this when it is turned on. The colour ribbon has a pin moulded into its underside which opens a microswitch in the ribbon carriage baseplate.

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These are some of the fonts that can be produced on the Epson EX-800.

addressable graphics in both the IBM mode and Epson mode. These give 240 dots per inch horizontally and 72 dots per inch vertically. In the main graphics mode, the EX-800 uses only the top eight of the nine pins in its print head. To print images or characters taller than eight dots, the machine does one line, advances the paper slightly, and then does another pass. It uses the same technique to fill in the spaces between the dots when printing in the NLQ modes.

Print speed is quoted as 250 cps (characters for second) in Draft Pica mode, 300 cps in Draft Elite and dropping to 50 cps in NLQ mode. I found that actual performance on text was somewhat slower than these figures but the EX-800 still really rips along in Draft mode and is quite a bit faster than typical daisy-wheel printers when in NLQ mode. It is also reasonably quiet for a dot-matrix printer.

In the draft mode, the character structure is formed from a 9 x 9 dot matrix, which gives an easily read type with true descenders (ie, on the letters g, j, p, q and y). In the NLQ mode, the double-pass operation of the print-head combined with paper movement, gives an 18 x 18 dot matrix which is very readable and has little evidence of dot structure, unless you look closely. The print quality is not quite as sharp or as densely black as from a daisy wheel printer but all who saw it agreed that it was satisfactory, especially considering the other attributes of this machine.

Line spacing is 1/6-inch, 1/8-inch or programmable in increments of 1/216-inch, as most dot-matrix printers are.

Paper

You can use either tractor-feed, roll or single sheets of paper in the EX-800 and you can obtain three copies at once, providing the paper thickness does not exceed 0.16mm. Paper width can be from 101 to 254mm wide in the case of tractor-feed while single sheets can be up to 216mm wide.

The ribbon cartridge is Epson's own design and is similar to those used in Diablo daisy-wheel printers. Life expectancy of the ribbon is about three million characters or about 500,000 words. Actual life will no doubt depend on the climatic conditions — printer ribbons tend to fade over a period of time, regardless of whether they are used or not.

Mechanical features

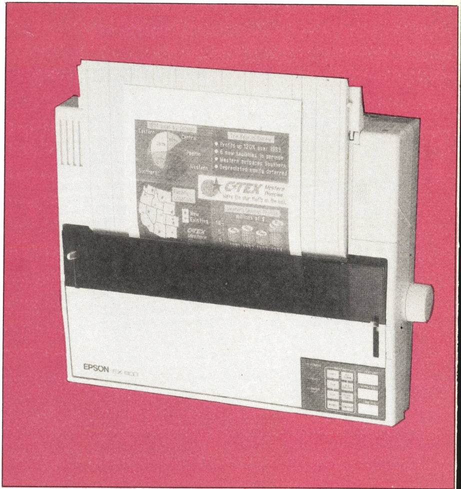
Gaining access to the inside of the EX-800 is quite interesting and shows the amount of ingenuity that Epson have brought to bear in this machine. It involves removing two screws, removing the SelecType panel, reaching in to unfasten two clips and the whole top lifts off to give access to the mechanism and electronics. And as with many dot matrix printers these days, the EX-800 is mechanically absurdly simple, with all the clever functions taken care of by software via its own processors. It has an 8K print buffer too, which is enough to store about two or three quarto pages of text.

Centronics (parallel) and RS232C (serial) interfaces are fitted as standard and a number of other serial interface boards are optional such as IEEE-448 and RS232C current loop.

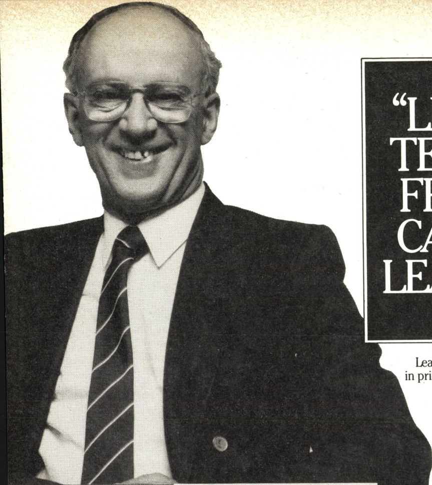
One feature of the design which we do think could be improved is the mains wiring. When the top of the case is removed the mains fuse lies fully exposed. It is adjacent to the mains switch and is directly connected to the active line of the mains. Since it is placed exactly where your hand would tend to go when lifting the printer, it presents a risk of very severe electrical shock, if the machine is still connected to the mains.

Sure, the manual tells you to switch off the printer and remove the power cord but those precautions always tend to be ignored and, in any case, the machine would have to be powered during servicing. A small change to the wiring would fix the problem and would make the machine safe to work on, even with power applied. We have suggested this to the local branch of Epson. They have agreed to have the wiring modified.

The EX-800 comes with a very comprehensive manual, by the way, which includes all the ESCape sequences and the technical details of the interfaces. In the manner of the manuals for the Epson PC reviewed last month, the spiral-bound 246-page manual is well-



As well as offering "near letter quality" text, the EX-800 can print graphics images in full colour.



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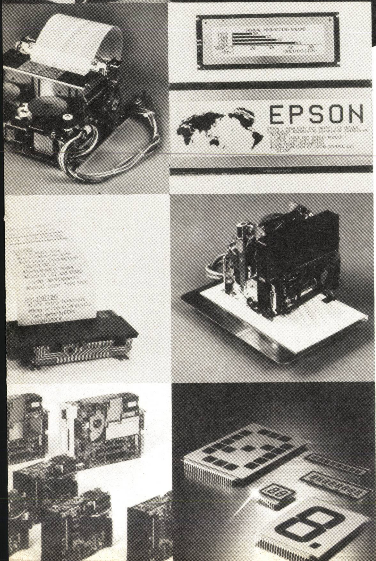

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Ideal for disco installations, bands and signwriters.

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MB 012C Mirror Cylinder (12″ length) 6″ Dia. – S52
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MIRROR BALL MOTORS:
A.C. 240V Heavy Duty – S100
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Cosmos Light

Mirror Ball housing 24 x GE 4515 lamps with provision for colour gel spinning in two planes, (vertical and horizontal)
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DOUBLE COSMOS:
Two Mirror Balls in each housing, 12 x GE 4515 lamps.
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HALF BALL ROTARY LIGHT:
14″ Dia. housing 6 x GE4515 lamps. Provision for Colour gel.
HLG 06 S780

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Metal framed housing rotating 360° in two planes, all with provision for colour gel.

RL 108, 8 x GE 4515 lamps S1800
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AUDIO/CHASER (DW 4LC 4000) **$360**
Pre-set Programmed Controller 4 Channels each 1000W.

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Programmable 7 channel with E-prom (16 programmes). Ideal for Advertising signs and Disco lighting.

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PLEASE NOTE: ALL DW CONTROLLERS COME WITH 12 MONTHS WARRANTY.

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written and easy to follow. It also includes a fold-out quick reference card with all the commands and oft-used data.

Apart from one small criticism on the power wiring, we could conclude at this point and state that this new printer from Epson is a fine machine which is certainly worth its purchase price. But it has another attraction which we mentioned at the beginning of this review: colour.

This is an optional kit which comprises a colour ribbon cartridge, a small motor, a Philips-head screwdriver and a small plastic lifting tool. A subsidiary manual explains how to install it. It takes about five minutes to do it. The colour ribbon is wider than the standard black ribbon and has three basic colours, red, blue and green plus black. The small motor in the kit is used to angle the ribbon carriage to bring each colour band of the ribbon into play.

After the installation you can do the self-test routine and get a printout in no less than seven colours: black, red, blue, violet, yellow, orange and green. The colours are vivid and stand out very well on white paper, except for yellow which normally does not contrast well with white.

These colours can be brought into play by using ESCape commands which can be embedded into some word processing programs or used in Basic routines. Where the colour really comes into its own is in the production of coloured bar charts and in complex graphics work. Epson include some examples of these in their manual which must have taken hours to develop on a computer but can be printed out in only a few moments. It is really very impressive.

Interestingly, you can change back to a black ribbon at any time and the printer will recognise this when it is turned on. The colour ribbon has a pin moulded into its underside which opens a microswitch in the ribbon carriage baseplate.

Well, to actually conclude this time, we are impressed with this printer. It is a highly capable, near-letter-quality printer with an excellent bonus option in the form of colour printing. It should be a winner.

Recommended retail price at the time of writing was $1050 plus tax for the Epson EX-800 while the colour option was expected to be about $150. For further information contact your Epson dealer or Epson Australia Pty Ltd, Unit 3, 17 Rodborough Rd, Frenchs Forest, NSW 2086. Phone (02) 452 5222.

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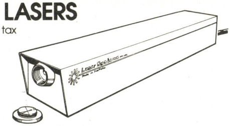
From $450 plus tax



Helium Neon Lasers
High quality, attractive price
The Lab laser series are economical Helium Neon lasers designed for laboratories, schools or clean workshops.
They are ideal for experiments, alignment and demonstrations and can be fitted with a variety of optics.
The hard sealed plasma tubes are rubber mounted for protection and the attractive case is finished in durable epoxy powder coat. All lasers are factory burnt in during a thorough test procedure.
Tubes, injection moulded tube mounts and 240V power supplies available separately, in kit form.

Models	Power	Beam divergence
LL05	0.5mw	1.54 mrad
LL1	1.0mw	1.23 mrad
LL2	2.0mw	1.23 mrad
LL5 M	5.0mw Multimode	8.0 mrad
LL5 S	5.0mw Single mode	0.96 mrad

Specifications:
Dimensions: height 75mm, width 75mm, length 405mm.
Power Source: 240V ac.
Wavelength: 632.8nm.
Mode: Tem$_{oo}$ except LL5 which is multimode.
Polarization: Random.
Beam diameter: ($1/e^2$) 0.65mm, LL5M 2.0mm, LL05, 0.52mm.
Output boss 1" x 32 tpi for scope or accessory mounts.
Warm up time full specification: 10 mins.
Operating Temp: -20°C + 50°C.

Options: ● 12 volt dc power ● key switch.

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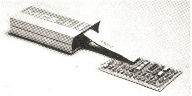

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New Products...

Product reviews, releases & services

Look Mum! — both hands

This gadget is called "Type-Right" and it allows you to learn to accurately speed type without the time and expense of evening classes.

Type-Right is a computerised teaching aid that guides you step-by-step on the path to becoming a proficient typist. First, it familiarises you with the keyboard. Then, with the aid of the manual, you practice finger placement and begin typing simple words, before moving on to complete sentences and paragraphs.

Main features of the machine include four Lesson Keys, a Class Key which offers nine lessons at various skill levels, and a Game Key which introduces you to speed touch typing. In the latter case, a series of letters creep across the built-in liquid crystal display and must be entered into the keyboard.

During each lesson, all relevant information is displayed on screen to gauge progress. A Speed Key calculates typing speed, while an Error Key determines accuracy and counts the number of mistakes.

Type-Right retails for just $69.95 and is available from your nearest Dick Smith Electronics store. For further information contact Dick Smith Electronics Pty Ltd, PO Box 321, North Ryde, NSW 2113. Telephone (02) 888 3200.

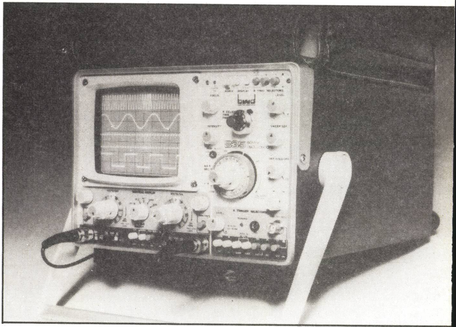
Military standard oscilloscope

Parameters Pty Ltd, the marketing arm of BWD Precision Instruments, has announced the release of BWD's Model 835 60MHz oscilloscope.

The Model 835 is a dual-trace oscilloscope suitable for both digital and analog applications. It is lightweight, compact and rugged in construction, and can be operated from 95-264V 48-440Hz power supplies without external switching.

The vertical amplifiers provide a full 60MHz bandwidth from 5mV to 20V per div and 50MHz at 2mV/div. For noisy waveforms or operation in noisy environments, a 20MHz bandwidth limit button is provided.

Sweep speeds range from 1s/div to 50ns/div and the 8 x 10cm CRT operates at 10kV. Other features include TV line and frame lock, low or high frequency reject, power line trigger and external trigger for both A and B time bases.



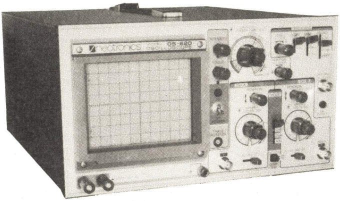
Function selection is by a pushbutton or a rotary switch. When switched to alternate sweep, four traces can be displayed — CH1 and 2 at the 'A' sweep rate and the CH1 and 2 at the delayed 'B' sweep rate.

The BWD 835 is supplied complete with two dual range 10:1 and 1:1 probes, plus an operation and maintenance handbook.

For further information contac Parameters Pty Ltd, Centrecourt, 25-27 Paul Street, North Ryde, 2113. Telephone (02) 888 8777.

YOUR SCOPE

OS-620



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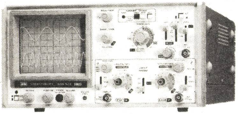
12 MONTH WARRANTY

GW THE ALTERNATIVE 20 MHz OSCILLOSCOPE

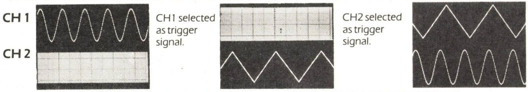
While other 20MHz CRO's are content to be like the rest, GW offers you the real alternative. The GOS-522 is a 2 Channel, CRO with a unique 'ALTERNATIVE TRIGGERING' mode between Channels 1 and 2. This allows you to compare test points between good and bad boards simultaneously!



GW Instrument's GOS-522 offers more 'real' facilities for your dollar:

- Fast 20ns/DIV sweep speed – for high precision
- Large 6 inch rectangular, internal graticule CRT
- Trigger Level Lock and Variable Hold-off – for operating ease
- DC Trigger Coupling – for low frequency signals
- AUTO NORMAL and SINGLE SHOT sweep modes

GW's "ALTERNATE TRIGGERING" MODE:



CH1 selected as trigger signal.

CH2 selected as trigger signal.

Alternate Trigger Mode selected: Both traces stably displayed.

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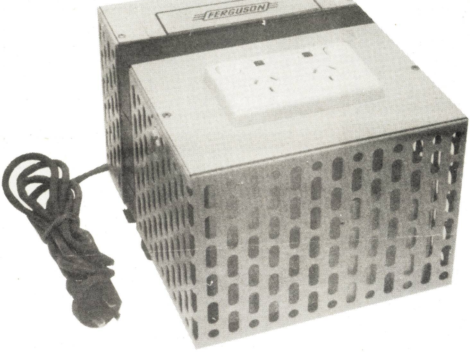
New Products...

Economic line conditioners



Ferguson's new "ferroresonant" type ELC line conditioners are designed to provide relatively constant output voltage when there are substantial fluctuations in the supply voltage. The basic component of these units is a ferroresonant (constant voltage) transformer.

The line conditioners are used in a number of applications where the following characteristics are required: (1) constant output voltage regardless of supply variations; (2) isolation from electrical noise; (3) modification of waveform from square to sine wave; and a combination of the above factors.

Six models are available with outputs between 160VA and 3500VA. They feature a common mode electrical noise rejection ratio greater than 120dB and are protected against output short circuits. They automatically respond to input voltage fluctuations and provide a sinusoidal output irrespective of electricity supply voltage distortions.

For further information contact Ferguson Transformers Pty Ltd, 7 Moorebank Avenue, Moorebank, NSW 2170. Telephone (02) 602 1222.

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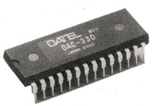


Ultra-fast 10-bit D/A converter

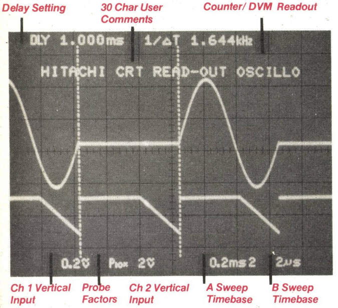
Datel has expanded its line of digital to analog converters (DACs) by introducing the DAC-330 which is a monolithic, video speed, 10-bit, 100MHz DAC, with a 14MHz bandwidth multiplying capability.

Applications include use in industrial and commercial graphic displays, high definition video and high speed signal processing. The chip operates from a −5V power supply, and features a low power consumption, dissipating a maximum of 1.48 watts.

The DAC-330 is supplied in a 28-pin dual-in-line plastic package with an operating temperature range of −20° to +75° C.

For further information contact Elmeasco Pty Ltd, 15 McDonald St, Mortlake, NSW 2137. (02) 736 2888.

ALL YOU NEED TO KNOW IS ON SCREEN



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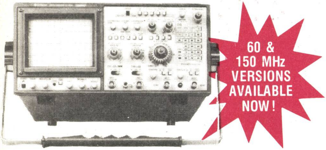

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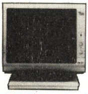

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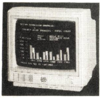

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Display Colours: 16 colours.
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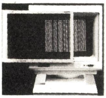

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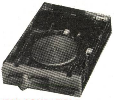

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- 25 pin "D" plug on computer end to Centronics 36 pin plug
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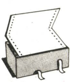

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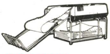

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  - **R.D.** Recieve Data
  - **R.T.S.** Request To Send
  - **C.T.S.** Clear To Send
  - **D.S.R.** Data Set Ready
  - **D.T.R.** Data Terminal Ready
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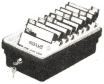

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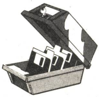

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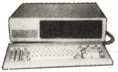

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Bench top multimeters

The new Fluke 367 benchtop multimeter features the combined analog/digital display seen in the Fluke 70 Series and the accuracy and input overload protection found in the Fluke 20 Series.

The front panel features a 15 degree slope for optimum visibility and switch access, and the carrying handle offers greater portability. A large storage compartment built into the rear half of the case allows the user to store test leads and small accessories inside the meter.

Other features include 0.1% basic DC accuracy, wide bandwidth AC response, 'Touch Hold", min/max and relative recording modes, autoranging with manual range selection, and a continuity/diode test beeper.

All current ranges, including the 10A range, are protected by fuses. The resistance function is overload protected by 500V RMS, and both AC and DC voltage functions are protected to 1000V RMS.

For further information contact Elmeasco Instruments Pty Ltd, 15 McDonald Street, Mortlake, 2137. Telephone (02) 736 2888.

Design programs for power transformers

A software package for the computer design of small power transformers has een released by Maneng Pty Ltd. It is uitable for Apple II and IIE computers nd is aimed at the educational and obbyist market.

Input specifications allow for three vindings of up to 2000V each, with two aps on each winding and with a maximum 2000VA single phase total rating.

Parameters which may be specified re temperature rise, impedance, copper loss, and core loss. If the design pecified is not practical, the program vill request modification of the input pecification.

For further information contact Maneng Pty Ltd, 64 Brisbane Water Drive, Koolewong, NSW 2256. Telephone 043) 41 1940.

PCB-mounting power relays

The new Fujitsu FRL270 series of iniature PCB mounted power relays re now available from IRH Compoents.

Measuring only 21.3 x 25.2 x 19.2mm, hey are designed for heavy duty, low oltage, printed circuit board applicaons in automotive and battery operated equipment.

A wide operating temperature range from −30°to +80°C is provided and the contacts handle 15A at 12V DC continuous and will handle 30A max overload current. Preferred coil operating voltages are 12V and 24V DC.

Also available from IRH are the Fujitsu FMR 800 series of mercury wetted contact relays. These are now available in total of eight packages.

All relays in this series are designed for PCB mounting and feature epoxy sealed metal cases for immersion cleaning.

Depending on the type selected, a range of coil voltages from 5V DC to 48V DC are available. Contact arrangements include single Form A, Form C, Form C latching and Form D.

Switching capacities up to 100VA (500V or 2A DC max) are standard for the Form C and Form D while the Form A contact is rated at 50VA.

Mercury wetted contacts ensure long mechanical life, stable contact resistance and bounce-free switching suitable for applications such as communications, data processing, measurement and control systems.

For more information contact IRH Components, 32 Parramatta Road, Lidcombe, NSW 2141. Telephone (02) 648 5455.

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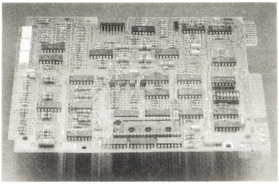
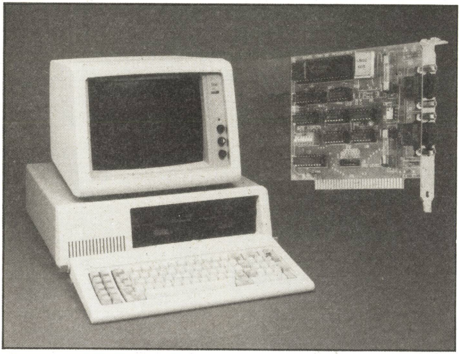


New Products...



Network/communication boards for IBM PC

Novatech Controls has released MetraByte's new COM-485 board which allows IBM PC/XT/AT and compatible computers to be networked over the RS-485 bus.

Unlike the RS-422 bus which allows multiple receivers but only a single transmitter on a bus, the RS-485 allows multiple transmitters and receivers to operate over a 2-wire bus, thus allowing a 'party line' network to be created.

Applications for the COM-485 include networking instruments, scanning and updating various user input and output devices (such as CRTs and keyboards etc), and any other communication application that requires more than one device to be networked to a personal computer.

For further information contact Novatech Controls Pty Ltd, 429 Graham Street, PO Box 240, Port Melbourne, Vic. 3207. Telephone (03) 645 2377.

General purpose I/O boards

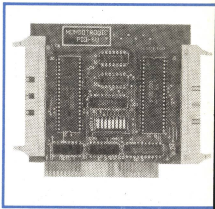
The Mondotronic PIO-6U is a general purpose I/O board for IBM PC/XT/AT or compatibles. Based on the popular 8255A-5 chip, it features 48TTL compatible and programmable I/O ports.

It is a short board and is switch addressable throughout the 10-bit PC-10 addressing range.

Connections are via two 50-pin polarised ribbon connectors fitted with a positive lock/ejection mechanism. Signa connections are designed to allow eithe standard or twisted-pair ribbon cable t be used.

A 5V supply with a separate ground i also supplied via the connector to powe possible external devices such as switching regulators, opto-couplers or pull-u resistors.

For further information contact Mondotronic, 560 Waverley Road, Gle Waverley, Vic. 3150. Telephone (03 232 4110.



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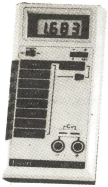
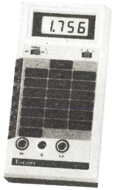


ESCORT EDC-110A CAPACITANCE METER

Check values and match capacitors for critical applications. Covers 200pF to 20,000 microfarads. Three and a half digit LCD display with 0.5% basic accuracy. Maximum resolution is 0.1pF. Fuse protection built-in. Complete with detailed manual and test clips **$129.72.**



ESCORT ELC-120 L/C/R METER

Measures resistance, capacitance and inductance all in one handy instrument. Three and a half digit LCD display with typical 1% accuracy. Covers capacitance from 200pF to 200microfarads in seven ranges with 1% accuracy and 0.1pF max resolution. Inductance ranges are from 2mH to 200H in 6 ranges with 0.1uH resolution and 2% accuracy. Also covers 20ohms to 20Mohms in seven ranges with 10milliohm resolution and 1% accuracy. Supplied with test clips and detailed manual **$264.32.**

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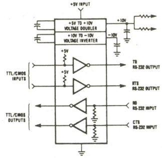
Also contains 2 drivers and receivers. Uses low power CMOS. Handles 30V input levels and provides a +9V output swing. Ideal for battery powered systems. **$12.96**



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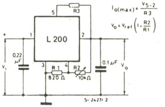
$I_{o(max)} = \frac{V_{5-2}}{R3}$
$V_o = V_{ref}\left(1 + \frac{R2}{R1}\right)$
5
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L 200
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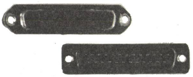

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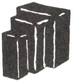
DB25S	**$3.20**
Backshell	**$2.20**
37-Way "D"	
DC37P	**$8.00**
DC37S	**$8.70**
50-Way "D"	
DD50P	**$9.00**
DD50S	**$9.80**
Centronics 36 Solder Male	**$6.45**
Centronics 36 Solder Female	**$9.50**
Centronics 36 IDC Male	**$10.50**
Centronics 36 IDC Female	**$11.85**

CONVERT YOUR MULTIMETER INTO A THERMOMETER

See ETI June 83 which features a project using the AD590JH (ETI-153). The AD590JH produces an output current proportional to absolute temperature. It's ideal for remote sensing as long cable runs have negligible effect on accuracy over a hundred metres or more! The simplest circuit requires one resistor and one pot and a battery, but better to build the proper circuit and get an accurate 10mV/degree centigrade output to put into your DMM. The AD590JH is only **$7.14**

Eddystone Die Cast Boxes



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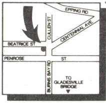

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Funway Into Electronics — the movie

Electronics is a fascinating and potentially rewarding hobby — for those who know the basics. The problem is, how does one get started? For the novice, finding out about the various parts and discovering what they do can seem a daunting prospect.

Well, Dick Smith Electronics have thought about the problem and have come up with what would seem to be the ideal answer: a half-hour videomovie entitled "Funway Into Electronics". This has been specially produced as an adjunct to DSE's enormously popular book "Funway Into Electronics, Vol.1".

Although aimed mainly at secondary school students, the videomovie is ideal for any novice wanting to get started in electronics. It introduces the viewer to the most common electronic components, explains how each part works, and concludes with the construction of a few simple projects. These projects are all taken from the Funway book and include a simple moisture detector and the now famous 'beer-powered' radio.

Of course, the videomovie won't turn you into an instant electronic expert. That's not its purpose. Instead, the aim is to provide the absolute beginner with an entertaining introduction to electronics so that the book may be tackled with confidence.

All the projects described in the Funway book can be built without lifting a soldering iron. Instead, the various parts are connected together by simply screwing their leads to a special plastic base (or breadboard). Special cut-out plans show where the parts actually go and all the projects are battery-powered to ensure complete safety.

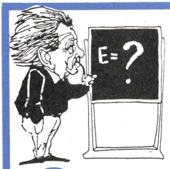
In all, there are some 20 projects described in "Funway Into Electronics, Vol.1". The book also includes a section which outlines the operation of each component (in greater detail tha the videomovie), shows what its circu symbol looks like, and describes marking codes.

In short, Dick Smith Electronics hav come up with a well thought out package that should appeal to schools and t would-be electronics enthusiasts alik And because the two are designed t marry together — the videomovie an the book — *Electronics Australia* an Dick Smith Electronics have combine to bring you the special offer shown o the facing page.

Here's what you get:

- a two-year subscription to *Electroni Australia*;
- the Funway Into Electronics videom vie (available in VHS and Beta);
- a project kit which includes the Fu way Into Electronics book plus all th necessary components to make up th 20 projects described in the book.

The above package costs just $9 which represents a saving of just ov $26 off the regular retail price. It mak an ideal Christmas gift and can be or ered from your nearest Dick Smi Electronics store or via the DSE ho line: (008) 22 6610.



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Hobbies in Australia" in April 1939. The title was changed to "Radio, Televisio
and Hobbies" in February 1955 and finally, to "Electronics Australia" in Apri
1965. Below we feature some items from past issues.**

Wireless
Weekly 3d

November 1936

Electric String Pick-Up: at the suggestion of the Philadelphia Symphony Orchestra, the Brush Development Company worked out an efficient amplification device to be applied to stringed musical instruments. The volume derived from one bass viola under such an arrangement is comparable to ten times the volume produced by a complete section of double basses in the orchestra.

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Women Can't Fly: (by a flying instructor
most women who take up flying do it ou
of sheer bravado. On the question o
teaching women to fly, the averag
woman is a fairly apt pupil, up to th
landing stage. But her judgment, particu
larly for approaches and landings, is ver
poor indeed. It takes a long time to ge
the principles of the two into her head.

Any time, I would sooner teach a ma
to fly, because although it takes a littl
longer, the ultimate result is certainl
much more gratifying.

Largest Radio Network: the Nationa
Broadcasting Corporation of Americ
which will celebrate its tenth anniversar
this year is the largest broadcasting ne
work in the world and the innovator o
the system of sponsored broadcasting.

The programs broadcast by the NB
over a period of a year number approx
mately 40,000. Over half a million artis
take part in more than 14,000 programm
hours. Gigantic fees are paid to those ar
ists, fees which can never be paid by an
other broadcasting company.

RADIO,
TELEVISION
and HOBBIES

November 1961

Commercial Satellites: following the initial successes with satellite communication, British and American engineers plan to cooperate closely to evaluate the technique and possibly develop it to the point where it becomes a major medium of international communication.

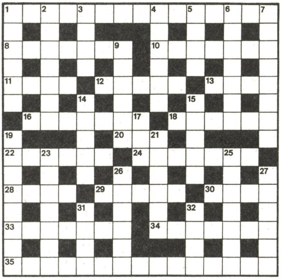
Rural TV: the Postmaster-General recently announced dates for the opening of the 13 national TV stations in rural areas. They are at Canberra, Newcastle, Wollongong, Orange, Richmond-Tweed, Bendigo, Ballarat, Latrobe Valley, Goulburn Valley, Darling Downs, Rockhampton, Townsville and Launceston.

European Satellite: The announceme
that the German Government is willing
principle to participate in a European o
ganisation for the development of spa
vehicle launchers, as proposed by t
United Kingdom and French Gover
ments, has focussed attention on the Br
ish Blue Streak first stage launcher.

Although the part that satellites a
the mastery of space will play in the f
ture cannot be wholly foreseen, the r
wards to be gained from such applicatio
as satellite communication systems a
obviously great indeed.

Colour VCR: (caption) the equipme
pictured above has been adapted for f
colour recording — the first time this h
been achieved with a single-head m
chine. It was demonstrated in Tokyo
the Tokyo Shibaura Electric Compan
The unit is claimed to be simple to op
ate and adjust and is free of many pecu
arities encountered with the four he
system of recording.

NOVEMBER CROSSWORD



ACROSS

1. Labour-saving form of slave labour. (10,5)
8. Caused a circuit fault. (7)
10. Radio base. (7)
11. Typical antenna site. (4)
12. Video output. (5)
13. Deliberately interferes with radio transmissions. (4)
16. Adhesive label. (7)
18. Record cover. (6)
20. Basic unit of 12 across. (3)
22. Part of a horn speaker. (6)
24. Electrochemical layer. (7)
28. Units of work in CGS system. (4)
29. Levels of application. (5)
30. Thirteenth word of phonetic alphabet. (4)
33. To power two. (7)
34. Data taken from a meter. (7)
35. Device used by a model-train enthusiast. (5,10)

DOWN

1. Add component into a circuit. (6)
2. Fault in a recording. (4-3)
3. Takes an examination. (4)
4. Allocate (frequency, etc). (6)
5. Authority in the recording industry. (1,1,1,1)
6. Type of electronic device, the bucket ————. (7)
7. Heavy light element! (8)
9. Controlled meter needle movement. (6)
14. Said of a system based on eight.(5)
15. A computer language. (5)
17. Common form of ferrite. (3)
19. These cause responses measured with strain gauges. (8)
21. Alter keyboard instrument to produce different keys. (6)
23. Again measure wire size. (7)
25. Current in a light globe surges in the ———— stage.(7)
26. Place for radio broadcasting. (6)
27. Circuit tester. (6)
31. State-wide network of power cables. (4)
32. Metric prefix. (4)

SOLUTION FOR OCTOBER

D	E	R	A	T	E	D	■	S	E	T	T	I	N	G
I	■	E	■	A	■	W	■	T	■	U	■	N	■	O
R	E	C	E	I	V	E	■	A	M	R	A	D	I	O
E	■	O	■	L	■	L	■	N	■	N	■	I	■	D
C	O	R	D	■	B	L	A	D	E	■	W	A	T	T
T	■	D	■	A	■	S	■	A	■	T	■	■	■	I
■	F	I	E	L	D	■	G	R	E	E	N	C	A	P
A	■	N	■	L	■	P	■	D	■	T	■	O	■	S
P	E	G	B	O	A	R	D	■	H	I	L	L	S	■
P	■	■	■	Y	■	I	■	H	■	A	■	L	■	D
L	O	C	K	■	O	N	O	F	F	■	D	E	C	I
E	■	L	■	D	■	T	■	B	■	K	■	C	■	O
T	W	O	W	I	R	E	■	A	L	E	R	T	E	D
O	■	U	■	A	■	R	■	N	■	Y	■	O	■	E
N	O	D	U	L	E	S	■	D	I	S	A	R	M	S

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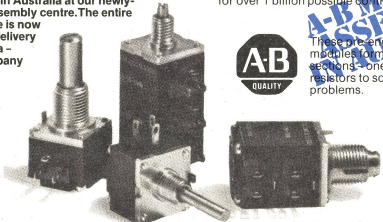

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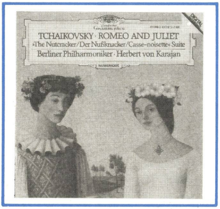
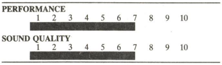
Compact Disc Reviews

by RON COOPER


DIGITAL
TCHAIKOVSKY · ROMEO AND JULIET
»The Nutcracker/Der Nußknacker/Casse-noisette« Suite
Berliner Philharmoniker · Herbert von Karajan

TCHAIKOVSKY

Romeo and Juliet
The Nutcracker Suite
Berlin Philharmonic conducted by Herbert von Karajan.
Deutsche Grammophon CD 410 873-2 DDD 1983
Playing time: 42 min 20 sec.



The Fantasy Overture Romeo and Juliet is one of Tchaikovksy's early spectacular orchestral works and was composed in 1869 to a basic plan suggested by Balakirev to whom the work was dedicated. It was an immediate success with its powerful and dramatic melodies and has become a concert favourite.

The Nutcracker Suite would clearly be Tchaikovsky's most popular and well-known composition, although if you read my review of Swan Lake in the August issue you will expect me to advise against this disc because it is not the complete version — and I will; but this is different.

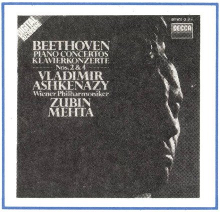
The Nutcracker Suite was the only set of pieces, of the three ballets put together by the composer to form a concert work in itself. The suites from Swan Lake and the Sleeping Beauty are not Tchaikovsky's arrangements. Hence, this disc does really contain two complete Tchaikovsky works.

However, I still feel the complete Nutcracker is still the only one to buy!

While this is a late recording and has virtually no background noise, it still reflects the tendency of many DGG recordings to favour the strings and subdue the woodwind and brass.

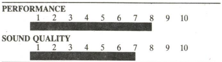
The acoustics are quite good and exhibit the moderate amount of natural reverberation expected from a large hall.

The players need no introduction and clearly show their skills but I did not like Karajan's tempos. The fiery Romeo and Juliet was much too sluggish and lacking the sparkle of some previous recordings while the Nutcracker was really a little too rushed, though with the skill of these performers it did not appear to suffer in detail. (R.L.C).



BEETHOVEN

Piano Concerto No.2, B flat major.
Piano Concerto No.4, G major.
Vladimir Ashkenazy piano.
The Vienna Philharmonic conducted by Zubin Mehta.
Decca CD 411 901-2
Playing time: 65 min 34 sec.



Just before the turn of the seventeenth century Beethoven had a dual career as a pianist and composer. Working hard on his piano technique, he travelled extensively and is known to have performed his own concertos on six occasions in Vienna, three in Prague, one in Pressburg an
possibly one in Berlin.

However, from 1800 onward the insid
ous process of deafness began to take i
toll, and he never actually performed h
fifth concerto. By 1816 he was almo
completely deaf and the thrill of phys
cally performing in front of an audien
was fast becoming a theoretical memor

This disc offers excellent value f
money with two concertos and long pla
ing time.

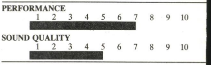
The recorded sound of the piano
quite magnificent, although I prefer V
Cliburn's interpretation of the fourt
Nor was I fully at ease with the orchestr
accompaniment which I felt could ha
been more articulate.

It is a very bright recording and t
miking appears to favour the strings,
the detriment of the wonderful woodwi
parts in these works, particularly in t
fourth.

As ever though, the CD format is s
perb with its quiet background. As
bonus, this disc comes with detailed not
on the works, and on the use of cadenz
by Beethoven. (R.L.C.)

STRAVINSKY
DEBUSSY

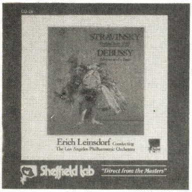
The Firebird Suite (1910)
Afternoon of a Faun
The Los Angeles Philharmonic Orch
tra conducted by Erich Leinsdorf.
Sheffield lab CD-24. AAD 1985
Playing time: 38 min 12 sec.



The Firebird ballet was written
1909-10 and the first performance
on June 25, 1910 under the baton
Gabriel Pierne and amongst the au
ence, and one of the first to congra
late the composer, was Claude Debus

The work was conceived by Diaghi
and after unsuccessful attempts by L
dov and Tcherepnin they were fina
given to 'the young Igor', who rose
the occasion.

Debussy's Prèlude à L'Après-M


STRAVINSKY
DEBUSSY
Erich Leinsdorf Conducting
The Los Angeles Philharmonic Orchestra
Sheffield Lab
"Direct from the Masters"

'un Faune was written after the latest ork of the symbolist poet Mallarmè. omposed under the influence of Wag- er, it is a somewhat abstract work in hich nothing is unequivocally stated.

I was very interested to review this isc, being familiar with the Sheffield ab's superb direct-cut LPs of some ears ago, such as Lincoln Mayorga olume III and the King James Version Harry James).

Sheffield go into much detail (three ages of pizzaz) discussing the musical, chnical and human problems of direct cording. On Leinsdorf they say "He as gone up the mountain and bashed it l out with God, or his surrogate." ow really what is this band of hifi nuts oming too? True, Leinsdorf and the rchestra do a fine job but let's leave it that.

They describe the magic of their tech- ical genius with: "This live perform- nce was recorded with a single-point, ereo microphone using tube electron- s designed and built by Sheffield Lab. his microphone technique was em- oyed to optimally capture the natural oustic perspective of the orchestra's rformance."

This may be true but this natural per- ective just sounds as though you are tting in a boomy barn some 20 metres om the orchestra with background pe hiss continuo. I don't really care by hat process modern technology de- ers the goods, it is the final audible sult that counts.

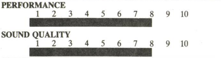
If it was from a popular company I ould say this disc was so-so, but this is omoted as direct from the master by effield Lab and sells for $35.95!

For all their tube electronics and ana- g recordings the result is noisy and ould be fixed. You don't ask an artist paint on a dirty canvas.

I have just received another version of the Firebird from Telarc which promises to be much better. I hope to bring it to you next month. (R.L.C.)

TIM FINN

Big Canoe
Virgin Records CDV2369 DDD
Playing time: 52 min 3 sec.



This is Tim Finn's second album since the break-up of of the band Split Enz. It bears witness to both his New Zealand origins and his ability to produce consistently catchy as well as thoughtful lyrics and tunes.

The title track, "Big Canoe" is perhaps the most evocative of the 'homeland'. The lyrics have connotations of a Maori legend, and the tune has a Polynesian percussion sound to it that would not have been out of place in the musical "South Pacific".

It's a catchy, emotional song helped along by its anthem-like chorus. I couldn't help enjoying the nationalist feeling which it produces through the use of a full-sounding orchestral strings arrangement and strong choir-like backing vocals.

"No Thunder - No Fire - No Rain" exhibits a poltical feeling for which New Zealand is well known, and seemed to me an indictment of the Bhopal disaster in India. The lyrics and the sounds of Indian percussion, especially the Tabla drums, help to conjure up this image.

Three other tracks apart from these struck me as (dare I say it) top 40 material. " Spiritual Hunger", which has been released as a single, features the talents of ex-Swinger Phil Jud. "Don't Bury My Heart" - another full sounding piece, is reminiscent of Jeff Lyn's use of strings in ELO. And "Hyacinth" is notable for the harp and sitar in the last stages.

With twelve songs in all, this is a CD to suit any mood, ranging from good background pop like "Searching the Streets" and "Hole in my Heart" to the goosebumpy thoughtfulness of "No Thunder - No Fire - No Rain", and a smattering of boppy brass and sax songs, like "Timmy", which were just made for dancing.

My only criticism is of the sound quality on some of the brass arrangements. On headphones they sounded distorted, but this was not noticeable during casual listening via my loudspeakers. (L.U.) EA

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Information centre

PC birdies won't stop

I recently built the PC Birdies project (May 1981) but am unable to get it working properly. I followed the instructions to the letter but instead of using the 74C14 IC, I used the equivalent 40106 from National Semiconductor.

When I switched it on for the first time, all I heard was a continuous high pitched whistle with a very fast trilling. I thought that the chirp oscillator may need adjusting so I changed the 47k resistor to a series of resistors totalling around 150k and found that the sound now resembled that of a starling.

I would like to know how to make the proper sound as I am getting quite frustrated with this circuit but would like to see it through to completion if I could. (J.M., Christchurch, NZ).

■ No problem, J.M. Just use the 74C14 IC specified in the original article. The 40106 has quite different hysteresis voltages and this is why your circuit is generating higher frequencies.

Problem with AM stereo decoder

I would like your advice about the AM Stereo Decoder (EA, October 1984) that I assembled from a kit and installed in the Playmaster AM/FM Tuner described in November 1978.

Adjusting the slug in coil L1 has no effect on the voltage on pin 19 of the IC, which remains steady at 3.7V, and the voltage on pin 10 remains too high at about 6.5V. Tuning in a station has no effect on these readings, and the pilot LED does not light up.

The output voltage of the LM317 is correct at 8.3V. I have replaced the three capacitors connected to L1, and the coil itself as I had a suitable former in my junk box, but these changes had no effect.

Reception of FM by the tuner is, of course, not altered, but AM reception is now very weak with a loud superimposed hum and is not stereophonic. (K.K., East Brighton, Vic).

■ The 6.5V reading at pin 10 is quite OK. It should simply be greater than 4.3V to indicate that the VCO is in lock. Similarly, the 3.7V at pin 19 indicates that the oscillator is operating correctly.

Your problem is probably due to the IF signal level on pin 3 of the MC13020P being incorrect. To set the correct level, monitor the DC voltage on pin 4 and adjust the series resistor to pin 3 until the meter reads about 2.5V.

Having said all that, our experience with the 1978 Playmaster AM/FM Tuner is that it is not a good candidate for stereo conversion. Its local oscillator is not sufficiently stable, and its tuning is quite critical.

Problem with 50V/5A power supply

I recently built the 50V/5A switchmode power supply as featured in your magazine some time ago (June 1983).

Unfortunately, on two occasions the output transistor has blown when a load has been switched in. When this happens, the output voltage jumps immediately to 50V and the overload lamp comes on. Coupled with this has been overheating of the 120 ohm 0.5W resistor in series with the potentiometer.

I would be grateful for any assistance you may be able to give to cure this problem. (G.W., Winston Hills, NSW).

■ The BD139 transistor (Q1) has probably been installed back-to-front. Note that the package outline drawing on the circuit diagram shows the base and emitter leads transposed. The same error was repeated in the MK.II version published in May 1985 and was only recently brought to our attention.

Crystal oscillator won't start

I have a problem with your Digital Frequency Meter described in December 1981.

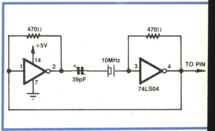
The crystal oscillator will not start when the unit is switched on cold. On a warm day there is no problem. Applying heat to the crystal area with a hair dryer also causes the oscillator to run. Use of freezer spray in the same area causes the oscillator to stop.

I tried reducing the 22M resistor to 10M as advised in previous correspondence but no improvement. I also change the 10MHz crystal and the 39pF capacito and the result is still the same - the osci lator will not run when cold. (G.B Merewether, NSW).

■ We suggest that you first check the ou put from the +5V regulator. If this is o the low side, it could be the cause of yo problem.

However, it seems more likely that th ICM7216A counter chip is at fault. W don't recommend that you replace though - it sells for about $70, so the exe cise would be rather expensive.

Instead, we suggest that you try fee ing the 7216A with an external crystal o cillator. To do this, remove all comp nents across pins 25 and 26 of the 7216 and feed the external timebase signal d rectly to pin 25.



Although we haven't tried it, the a companying circuit should make a sat factory 10MHz crystal oscillator. It based on a single low-cost 74LS04 T chip.

Modifying the Playmaster 60/60

I have read with interest the series articles describing the Playmaster 60/ stereo amplifier and am impressed w its specifications and constructional si plicity. It appears that this amplifier m form the basis for updating my prese unit.

At present, however, I operate a p of loudspeakers with electronic cro overs. A replacement amplifier needs t facility to make input and output conn tions between the pre and main pow amplifiers.

In view of the above, would you plea advise whether and how:

(1) preamp outputs and power amplif inputs may be provided;

(2) a second power amplifier may be constructed on the 60/60 PCB - ie, without the controls, preamp etc;
(3) the original 60/60 power supply may be used for the additional power amplifier or whether the power supply should be duplicated. (G.B., Dalkeith, WA).

■ We elected not to provide separate preamplifier outputs and power amplifier nputs on the Playmaster 60/60 for two easons: to simplify construction and to ninimise cost. However, it should be possible to break the signal chain at the wiper on the balance control to provide hese facilities.

Note that the necessary connections between the balance control and the xtra sockets would have to be run using hielded cable.

It is perfectly feasible to construct eparate power amplifier stages on another PCB. Just leave out the circuitry for he tone controls and the input preampliier stages. It will, however, be necessary o duplicate the power supply.

Back-up for 300VA inverter

Recently I built, for a neighbour of urs, the EA 300VA inverter. This is unctioning correctly and he seems happy ith its performance.

This same neighbour normally runs his ouse from a diesel generating set (also harging household batteries). He has sked me to find out if it would be possile to run his house (in the event of reakdown in his main system) from his incoln electric welding unit which puts ut 240VDC, by eliminating the transormer in the inverter and substituting pgraded power transistors (240V).

I realise this sounds a little rough and ady but it is intended for emergency se, as we are a long way from the mains ower grid and he is not financial enough afford the cost of a backup generator the regular type.

Any help you may be able to give will greatly appreciated. (R.D., Nimmitael, NSW.)

Your proposition is an interesting one d one that might work in a pinch. here are several points to be considered ough.

First, the regulation of a welder may t be good enough to run household apiances without the possibility of damage om over-voltage. Similarly, the output the welder's generator (or is it an altertor?) may have large DC spikes from e commutator which could cause probms. In theory, many household applices could be run from 240VDC. Heats, lights and appliances with universal motors will all run from DC. However, other appliances containing transformers or induction motors would not run.

If you wanted to use the welder's DC output to generate 240VAC at 50Hz, you would not use the inverter circuitry. Instead, you would require a DC to AC converter which would need a set of four high voltage transistors (or maybe transistors in parallel to obtain the necessary current rating) in a bridge configuration.

The transistors could be driven with a sinewave or in pulse width modulation together with a filter to obtain a sinewave output.

Unfortunately though, having set out the theory, we are not in a position to help you put it into practice. A more practical standby may be to hire or purchase a small petrol powered generator.

Notes and Errata

FENCEMASTER ELECTRIC FENCE (October 1986, 3/MS/-): The 470k resistor connected to the anode of PUT Q3 should be replace by a 1M resistor to ensure reliable cycling.

240V LAMP SAVER (June 1986, File 2/PC/45): the parts layout diagram shows two resistors transposed. The 100k resistor connected to the base of Q1 (in the right hand corner) should be 1M while the 1M resistor next to D5 should be 100k. The circuit diagram is correct.

Note that the circuit will still work as shown, although the soft start characteristic will be altered slightly.

Constructors should also note that the circuit will not work correctly with a 1W zener diode. The 18V/400mW zener specified must be used.

EXTRA CHANNELS FOR THE DSE EXPLORER (September 1986, File 2/TR/63): the circuit diagram shows pins 3 and 7 of the 4008B transposed with pins 8 and 9. The parts layout diagram is correct.

PLAYMASTER 60/60 STEREO AMPLIFIER (May-July 1986, File 1/SA/75): some readers have reported overheating of the output transistors and the heatsink. This problem is due to the fact that retailers are supplying a steel chassis whereas the prototype used a black anodised aluminium chassis which had much better heatsinking characteristics. In addition,

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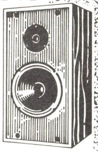

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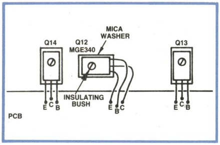
the ventilation slots in the kit versions are smaller than those of the prototype.

The cure is simple and effective. To eliminate the possibility of thermal runaway of the output transistors, the VBE multiplier transistor (Q12) in each channel should be replaced by an MJ340 transistor. This will give vastly improved thermal tracking and will keep the quiescent current virtually constant with increasing temperature.

The new transistor should be bolted to the heatsink using a mica washers for insulation and with heatsink compound smeared on all mating surfaces. Note that the base and collector leads of the MJ340 must be crossed over to suit the hole locations left by the original BC547. The accompanying diagram shows the details.



Finally, to compensate for the lower VBE of the MJ340, the 470 ohm resistor between the base and collector of Q12 should be increased to 1k.

Preamplifier

continued from page 69

phono output to the disc input plus a tuner, CD and auxiliary unit (if available) to their respective inputs. A tape player can be connected to the tape in the tape out terminals.

The output left and right terminals connect to the inputs of a power amplifier or to the tape monitor input of an integrated amplifier. The amplifier is powered using the mains socket at the rear of the IR preamplifier.

For best results, press the normal switch and set the volume indication on the level set display to mid setting. Now set the volume control of your integrated amplifier to normal listening level. The volume can now be adjusted with the IR Remote Preamplifier controls.

Note that the VR1 and VR201 trim pots adjust the output level of the preamplifier. This can be set to give sufficient sensitivity for your amplifier.

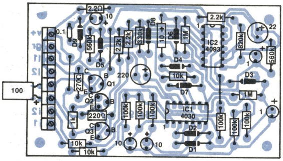
SCREECHER CAR BURGLAR ALARM (August 1986, File 3/AU/49): due to an oversight, an incorrect PCB artwork was sent to some PCB manufacturers. This incorrect artwork can be quickly recognised by inspection of the i1 and i2 terminal labels, which are transposed (ie, i2 will be nearest the bottom of the artwork).

Although the error was soon discovered and the faulty artwork withdrawn, some readers may have obtained the faulty PCB. This can be modified by cutting the copper tracks with a razor blade and installing wire links on the underside of the PCB as appropriate.

The necessary modifications are as follows: Q3's emitter must be connected to the base of Q2 instead of to the emitter; 220 ohm resistor must be connected b tween V+ and Q3's base; one side of th wire link should go to V+ instead of t the 0.1uF ceramic capacitor adjacent t D9; and the 0.1uF capacitor lead shoul go to the cathode of D9.

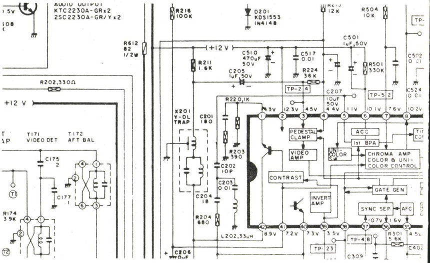
To further complicate matters, the r placement artwork (and the artwork pul lished in the magazine) have a track mis ing between the emitter of Q2 and the ad jacent end of the 220 ohm resistor. Thes two pads ahould be joined using a wi link. The parts layout diagram on page 2 was correct.

To assist readers, the parts layout di gram and a corrected PCB pattern are r printed below.



Parts layout for the Screecher Car Burglar Alarm.

CONVERT YOUR TV TO A COMPUTER MONITOR (August 1986, File 2/CC/95): the main circuit diagram (Fig.1) was cropped such that R202 is n shown. The accompanying diagra shows the position of R202.



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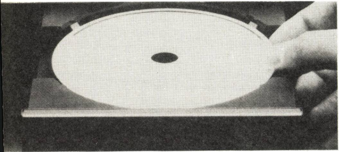

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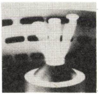

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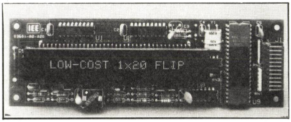

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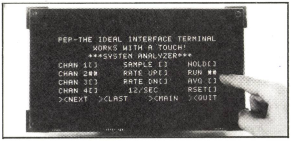
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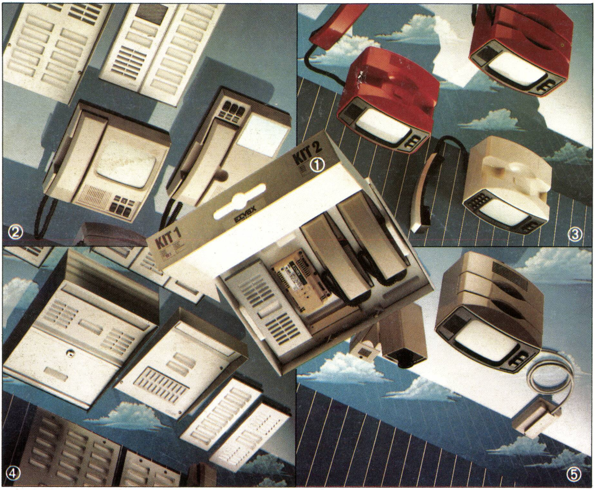

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